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Effects of Blended NPSB Fertilizer on Yield and Yield Related Traits of Potato (*Solanum tuberosum* L.) Varieties in Oda Bultum District, Eastern Ethiopia

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8e9)hegn *sse2)- :ibe;)l *lem)5ehu- <)ssu . oh)mmed. 022ects o2 =lended %'$= >ertili9er on :ield)nd :ield +el)ted ?r)its o2 'ot)to (*Solanum tuberosum* @.) A)rieties in (d) =ultum 1istrict- 0)stern 0thiopi). *American Journal of Bioscience and Bioengineering*. Aol. 9- %o. 1- 2021- pp. 21-32. doi: 10.11 !"/j.bio.20210901.1!

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Abstract: 'ot)to is)n import)nt 2ood)nd c)sh crop in e)stern 0thiopi) including (d) =ultum 1istrict. 4owe3er- there is no in2orm)tion on the role o2 blended %'$= 2ertili9er reBuired to produce tuber 5ield)nd tuber Bu)lit5 tr)its. * 2ield eCperiment w)s conducted in (d) =ultum 1istrict- under r)in2ed during 201" cropping se)son- with the objecti3es o2)ssessing the e22ects o2 blended %'$= 2ertili9er r)tes on 5ield-rel)ted tr)its)nd tuber 5ield o2 pot)to 3)rieties)nd to estim)te the cost-bene2it o2 the)pplic)tion o2 blended %'$= 2ertili9er in pot)to production. ?he tre)tments consisted o2 two pot)to 3)rieties (=ubu)nd 8ud)nie))nd siC r)tes o2 %'$= (0- 100- 1&0- 200- 2&0)nd 300 ;g %'$= h)$^{-1}$) 2ertili9er. ?he eCperiment w)s l)id out)s) +)ndomi9ed /omplete =loc; 1esign in) C 2 2)ctori)l)rr)ngement)nd replic)ted three times. *n)l5sis o2 3)ri)nce re3e)led th)t the two m)in 2)ctors; blended %'$=)nd 3)riet5 h)d) signi2ic)nt e22ect on)ll tr)its eCcept th)t 2ertili9er)nd 3)riet5 h)d) non-signi2ic)nt e22ect on d)5s to &0D emergence. #nter)ction o2 blended %'$= 2ertili9er)nd 3)riet5 h)d) signi2ic)nt e22ect on tot)l tuber number/hill-)3er)ge tuber weight- tot)l)nd m)r;et)ble tuber 5ields (t h)$^{-1}$). 8ud)nie 3)riet5 emerged- 2lowered)nd m)tured e)rlier th)n =ubu. 0)rl5 2lowering o2 the crop w)s obser3ed in) plot which did not recei3e 2ertili9er while the)pplic)tion o2 %'$= 2ertili9er del)5ed 2lowering)nd m)turit5 o2 pl)nts th)t recei3ed highest r)tes %'$= 2ertili9er (200- 2&0)nd 300 ;g h)$^{-1}$). ?he highest tot)l tuber number hill^{-1} (1 .00) w)s obt)ined 2rom 8ud)nie 3)riet5)t the)pplic)tion o2 200 ;g h)$^{-1}$ %'$= 2ertili9er. ?he highest proportion o2 sm)ll si9e tubers were obt)ined 2rom plots th)n recei3ed no 2ertili9er while the l)rgest proportion o2 l)rge si9e tubers were obt)ined 2rom plots th)t recei3ed 200- 2&0)nd 300 ;g h)$^{-1}$ %'$= 2ertili9er. ?he highest tot)l)nd m)r;et)ble tuber 5ields o2 30.&&)nd 2E.22 t h)$^{-1}$- respecti3el5 were obt)ined 2rom 8ud)nie 3)riet5 with the)pplic)tion o2 200 ;g h)$^{-1}$ %'$= 2ertili9er. 8ud)nie h)d) signi2ic)ntl5 higher speci2ic gr)3it5 (1.0"&g/cm^{3})- tuber dr5 m)tter (21.9"D))nd st)rch content (1&."2D) while pl)nts produced tubers with highest speci2ic gr)3it5- tuber dr5 m)tter)nd st)rch content due to the)pplic)tion o2 200 ;g h)$^{-1}$ %'$= 2ertili9er. . oreo3er- the highest net bene2it o2 11 -330.2! =irr h)$^{-1}$ with !0 D m)rgin)l r)te o2 return were obt)ined 2rom growing o2 8ud)nie 3)riet5 with the)pplic)tion o2 200 ;g h)$^{-1}$ %'$= plus 100 ;g h)$^{-1}$ ure) 2ertili9er th)t could be recommended 2or production o2 pot)to in the stud5)re).

Keywords: .)rgin)l +)te o2 +eturn- .)r;et)ble)nd ?ot)l ?uber :ield- ?uber $peci2ic 8r)3it5- 1r5 .)tter /ontent

1. Introduction

'ot)to (*Solanum tuberosum* @.) is one o2 the most import)nt 2ood crops in m)n5 countries o2 the world. #n 3olume o2 production- it is the 2ourth most import)nt crop)2ter whe)t- m)i9e)nd rice with)nnu)l production o2 31!.1 million tones culti3)ted on)bout 1".1 million hect)res o2 l)nd F1G. 'ot)to is reg)rded)s) high-potenti)l 2ood securit5 crop bec)use o2 its)bilit5 to pro3ide) high 5ield o2 high-Bu)lit5 product per unit input with) shorter crop c5cle F2G.

#t is) m)jor p)rt o2 the diet o2 h)l2) billion consumers in the de3eloping countries F3G. 'ot)to is)n import)nt 2ood)nd c)sh crop in 0)stern)nd /entr)l *2ric)- pl)5ing) m)jor role in n)tion)l 2ood securit5)nd nutrition- po3ert5)lle3i)tion)nd income gener)tion-)nd; pro3ides emplo5ment in the production- processing)nd m)r;eting sub-sectors F!G.

'ot)to h)s been introduced in to 0thiopi) in 1"&9 b5) 8erm)n =ot)nist c)lled *Schimper*. $ince then- pot)to h)s become)n import)nt tuber crop in m)n5 p)rts o2 0thiopi))nd it r)n;s 2irst)mong root)nd tuber crops both in) 3olume o2 production)nd consumption 2ollowed b5 c)ss)3)- sweet pot)to-)nd 5)m where sm)llholder 2)rmers)re the m)jor producers)s 2ood-)nd c)sh crop (centr)l st)tistic)l)genc5 F&G. >urthermore- in 0thiopi) root)nd tuber crops co3ered ne)rl5 1. 3D o2 the)re) under)ll HH*meher*II crops in the countr5 F&G. 'ot)toes- sweet pot)toes)nd t)ro/*godare*)ccounted 2or 29."!D- 22.91D)nd 19.E2D o2 the tot)l root)nd tuber crop)re) culti3)ted- respecti3el5.

#n 0thiopi)- pot)to production re)ched 9. "9 million tons 2rom 9- 10 hect)res in 201E/1" cropping se)son)s comp)red to 9E! thous)nd tons 2rom 1 -000 hect)res in 2001)nd the number o2 households growing incre)sed 2rom 1.1& million in 2001 to o3er 1.19 million in HH*meher*II 201E/1" F&G. 1espite high potenti)l production en3ironments)nd m)r;ed growth- the n)tion)l)3er)ge pot)to 5ield in 2)rmerIs 2ield in 0thiopi) is onl5 13.92 t h)$^{-1}$- which is lower th)n the eCperiment)l 5ields o2 o3er 3" t h)$^{-1}$ done)t 4olet))gricultur)l rese)rch center)nd the world)3er)ge o2 19 t h)$^{-1}$ F G.

$e3er)l 2)ctors limiting crop 5ields h)3e been identi2ied b5 m)n5 rese)rchers in 0thiopi); the m)jor ones)re l)c; o2 st)ble well-)d)pted 3)rieties- l)c; o2 ;nowledge in using optimum nutrient suppl5 in e3er5)re) o2 production 9one-)n insu22icient suppl5 o2 dise)se)nd insect pestsI toler)nt 3)rieties FEG. . ost 0thiopi)n soils l)c; most o2 the m)cro)nd micro nutrients th)t)re reBuired to sust)in optim)l growth)nd de3elopment o2 crops F"G.

#n 0thiopi)- 2ertili9er use h)s incre)sed not)bl5 since 1990 F9G. 4owe3er- there is no rel)ted)tt)in)ble 5ield incre)se- especi)ll5 in pot)to F10G. ?his m)5 be due to the 2)ct th)t sm)ll sc)le 2)rmers do not h)3e the reBuired resources to m);e or purch)se 2ertili9er)nd/or the 2)rmers do not)ppl5 the optimum)mount o2 2ertili9ers r)tes- 2ertili9er t5pes to pot)to 3)rieties to h)r3est m)Cimum 5ield 2rom their l)nd due to the)bsence o2 recommend)tion th)t best 2it to their speci2ic)re))nd production s5stem F10G. >urthermore- the highest biologic)l)nd economic)l 5ield o2 pot)to w)s obt)ined 2rom combined)pplic)tion o2 200 ;g h)$^{-1}$ %'$=)nd 92 ;g h)$^{-1}$ % 2or =elete 3)riet5)t =)d)w)cho 1istrict- 4)di5) Jone F11G.

/hemic)l 2ertili9er sources in 0thiopi)n)griculture h)3e been limited to ure))nd 1i)mmonium 'hosph)te (1*') o3er the p)st 2i3e dec)des. ?hese t5pes o2 2ertili9ers deli3er onl5 nitrogen)nd phosphorus which m)5 not s)tis25 the nutrient reBuirements o2 the crops including pot)to in the)gricultur)l soils. #n)ddition- 0thiopi)n soil l)c;s most o2 the m)cro)nd micronutrients th)t)re reBuired to sust)in optim)l growth)nd de3elopment o2 crops F12G. /onseBuentl5- the 5ield o2 pot)to crops in 0thiopi) is much lower th)n the world)3er)ge production per hect)re F G. 4owe3er- soil tests through the 0thio-$#$ re3e)led th)t 0thiopi)n soils)re de2icient in other micronutrients li;e =)nd others. ?his is)ttributed to high soil erosion- remo3)l o2 nutrients b5 crops-)nd continuous cropping with no replenishment o2 nutrients-)nd in)deBu)te)nd unb)l)nced use o2 org)nic)nd inorg)nic 2ertili9ers F13G.

?he 0)stern)re) o2 pot)to production in 0thiopi) m)inl5 co3ers the 0)stern 4ighl)nds- especi)ll5 0)st 4)r)rghe Jone. #n <est 4)r)rghe highl)nd- (d) =ultum 1istrict is one o2 the pot)toes produces under r)in2ed)nd irrig)tion s5stem. 4owe3er- the 5ield o2 pot)to is low due to the)bsence o2)re))nd 3)riet5 speci2ic recommend)tion o2 2ertili9er r)tes)nd short)ges o2 Bu)lit5 seed tubers)re)mong this m)n5 other m)jor problems 2ound in the)re) (person)l communic)tion).

#n the stud5)re)-)bsence o2)re))nd 3)riet5 speci2ic recommend)tion o2 2ertili9er r)tes)nd short)ges o2 Bu)lit5 seed tubers)re the c)uses o2) l)rge proportion o2 sm)ll-si9ed tubers production th)t c)n be c)tegori9ed)s unm)r;et)ble tubers)nd low 5ield. (n the other h)nd- the soils in the)re) were identi2ied to be de2icient in blended 2ertili9er %'$= 2ertili9er (1".9D %- 3E.ED '$_2$($_&$- .9&D $)nd 0.1D =) which is recommended to substitute 1*' 2ertili9er in (d) =ultum 1istrict F1!G. #n)ddition- this blended 2ertili9er is under distribution to be)pplied 2or)ll crops. $ince the growth- 5ield)nd pro2it)bilit5 o2 pot)to production is l)rgel5 in2luenced b5 the 2ertilit5 st)tus o2 the soil)nd 3)riet5 selection- so it is necess)r5 to conduct rese)rch in the)re) to identi25 3)riet5)nd r)te o2 2ertili9er th)t meets the 2)rmersI interest to obt)in high 5ield- tuber Bu)lit5)nd pro2it 2rom the production o2 pot)to. ?here2ore- the present stud5 w)s conducted to)ssess the e22ect o2 blended %'$= 2ertili9er on tuber 5ield- 5ield-rel)ted)nd tuber Bu)lit5 tr)its o2 pot)to 3)rieties-)nd to estim)te cost-bene2it o2 the)pplic)tion o2 blended %'$= 2ertili9er)t di22erent r)tes 2or the production o2 pot)to in (d) =ultum 1istrict.

2. Materials and Methods

2.1. Description of Experimental Site

?he stud5 w)s conducted under r)in-2ed conditions during 201" m)in cropping se)son)t (d) =)so HI*Kebele*II >)rmer ?r)ining /enter (>?/) in (d) =ultum 1istrict- 0)stern 0thiopi). (d) =ultum is one o2 the 1istrict 2ound in <est 4)r)rghe Jone. #t is loc)ted in the 0)stern p)rt o2 the countr5 3 2 ;m 2rom *ddis *b)b))nd 3E ;m 2rom /hiro- Jon)l town.

8eogr)phic)ll5- the eCperiment)l site is loc)ted)t the l)titude o2 "K &!I 0I I %orth)nd longitude o2 !0K !EI 10I I 0)st (>igure 1)- with)n ele3)tion o2 1"01 meters)bo3e se).

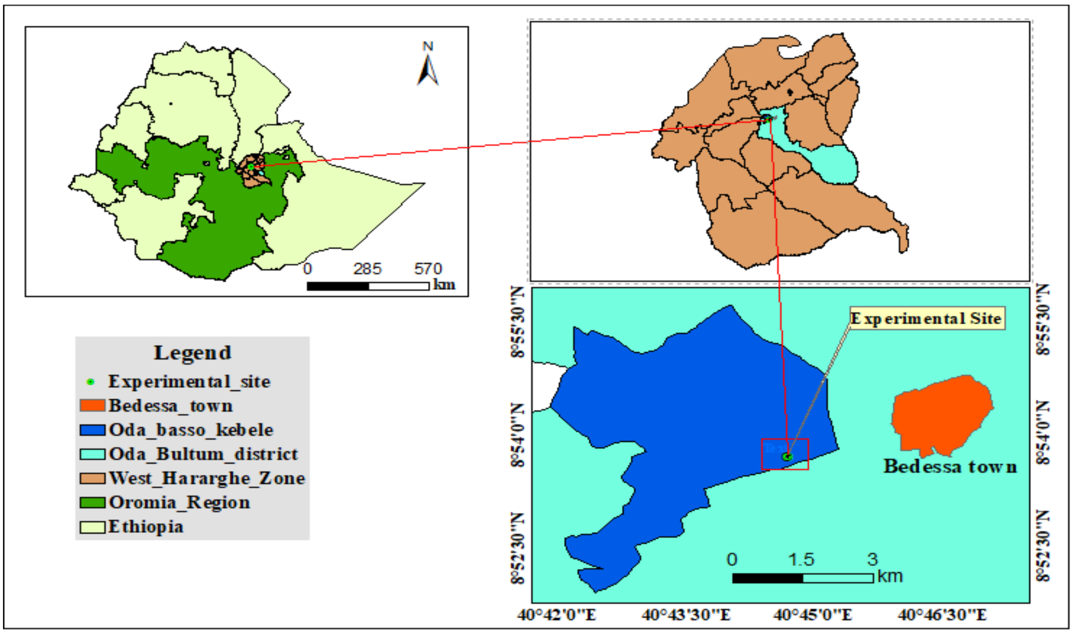

Figure 1. *Map of study area.*

?he)re) h)s) me)n)nnu)l minimum)nd m)Cimum temper)ture o2 12.23K/)nd 2!.E3K/- respecti3el5. 1uring the 201"/19 crop growing se)son- the tot)l)mount o2 r)in2)ll recei3ed w)s 12 1.2E mm. 4owe3er- the)re) recei3ed)bout &00.29 mm o2 tot)l r)in2)ll during the eCperiment)l period (Lul5 to (ctober 201").

?he (d) =ultum 1istrict h)s two r)in5 se)sons; th)t is-) short r)in5 se)son 2rom the end o2 .)rch to e)rl5 .)5)nd) m)in r)in5 se)son th)t eCtends 2rom Lune to $eptember. ?he me)n m)Cimum temper)ture w)s)bout 2E. 9K/ in .)rch month. ?he soil is cl)5 in teCture)nd slightl5)cidic with) p4 3)lue o2 .2E.

2.2. Treatments and Experimental Design

?he tre)tments consisted o2 two impro3ed pot)to 3)rieties (=ubu-)nd 8ud)nie))nd siC di22erent r)tes o2 %'$= 2ertili9er (0- 100- 1&0- 200- 2&0)nd 300)- plus 100 ;g h)$^{-1}$ ure))pplied to)ll plots eBu)ll5 eCcept control. %utrients)mounts in e)ch 2ertili9er tre)tment)re presented in (?)ble 2). ?he eCperiment w)s l)id out)s) +)ndomi9ed /omplete =loc; 1esign (+/=1) in) 2 C 2)ctori)l)rr)ngement)nd replic)ted three times per tre)tment. ?here were 12 tre)tment combin)tions- which were)ssigned to e)ch plot r)ndoml5. ?he tot)l number o2 plots w)s 3)nd e)ch plot h)d) gross)re) o2 1 .2 m^2 with 3. m length)nd !.& m width. 0)ch plot cont)ined siC rows o2 pot)to pl)nts- with e)ch row)ccommod)ting 12 pl)nts with) tot)l popul)tion o2 E2 pl)nts per plot)t the sp)cing o2 0.E& m)nd 0.30 m between rows)nd pl)nts- respecti3el5. ?he sp)cing between plots)nd)dj)cent bloc;s w)s 1 m)nd 1.& m- respecti3el5. 'l)nts in the two outer rows-)s well)s those)t both ends o2 e)ch row- were not considered 2or d)t) collection to)3oid edge e22ects.

2.3. Experimental Procedure and Crop Management

?he eCperiment)l 2ield w)s culti3)ted 2rom end o2 *pril to mid Lul5 201" to) depth o2 2& - 30 cm using oCen to 2ine soil tilth. +idges)nd plots were le3eled m)nu)ll5. . edium-si9ed)nd well-sprouted pot)to tubers were pl)nted on ridges)t the speci2ied sp)cing b5 pl)cing one tuber per hill. ?he tubers were pl)nted on Lul5 2"- 201")t the sp)cing o2 E& cm between rows)nd 30 cm between seed tubers. ?he blended %'$= 2ertili9ers)t the speci2ied r)tes were)pplied b5 b)nding the gr)nules)t the depth o2 & cm below)nd)round the seed tuber)t pl)nting 2or blended %'$= 2ertili9er. *ll blended %'$= 2ertili9er w)s)pplied)t pl)nting- while ure) 2ertili9er w)s)pplied in three splits (M))t pl)nt emergence- (N))t the 2irst e)rthing up)nd the rem)ining (M))t the initi)tion o2 tubers ()t the st)rt o2 2lowering))s per the recommend)tion. *ll ure))pplic)tions were m)de)t) time when the soil moisture is not eCcessi3el5 high to)3oid le)ching o2 %. *ll other cultur)l pr)ctices were 2ollowed)s per the recommend)tion 2or r)ising) success2ul crop.

2.4. Data Collection Measurements

Days to flowering were recorded when &0D o2 the pl)nt popul)tion)tt)ined the 2lowering st)ge. *Plant height* w)s determined b5 me)suring height 2rom the b)se o2 the m)in shoot to the)peC)t 2ull blooming. *Number of stems per hill* w)s recorded)s the)3er)ge stem count o2 2i3e hills per plot re)ched)t 2lowering st)ge. (nl5 stems)rising 2rom the mother tuber were considered)s m)in stems. F1&G. *Days to physiological maturity* w)s recorded when the le)3es o2 E0D o2 the pl)nts in the plot turned 5ellowish. *Tuber number*)nd 5ield were represented b5 t);ing the)3er)ge o2 1 hills per plot.

2.5. Data Analysis

?he d)t) were subjected to)n)l5sis o2 3)ri)nce (*%(A*) using 8en-$t)t rele)se 1 th 0dition so2tw)re F1 G. ?he result interpret)tions were m)de 2ollowing the procedure o2 8ome9

)nd 8ome9)nd me)ns o2 signi2ic)nt tre)tment e22ects were sep)r)ted using the >ishersI 'rotected @e)st $igni2ic)nt 1i22erence (@$1) test)t &D prob)bilit5 le3el o2 signi2ic)nce.

2.6. Partial Budget Analysis

?he economic)n)l5sis w)s c)rried out b5 using the methodolog5 described in in which pre3)iling m)r;et prices 2or inputs)t pl)nting)nd 2or outputs)t h)r3esting were used F1EG. *ll costs)nd bene2its were c)lcul)ted on) b)sis in =irr. ?he concepts used in the p)rti)l budget)n)l5sis were the me)n m)r;et)ble tuber 5ield o2 e)ch tre)tment- the gross bene2it (8=) h)$^{-1}$ (the me)n m)r;et)ble tuber 5ield 2or e)ch tre)tment))nd the 2ield price o2 2ertili9ers (the costs purch)sing o2 blended %'$=-)pplic)tion costs)nd cost o2 tuber 5ield tr)nsport)tion to the ne)rer m)r;et).

3. Results and Discussion

3.1. Physico-chemical Properties of the Experimental Soil

?he results o2 the pre-sowing composite soil s)mple l)bor)tor5)n)l5ses indic)ted th)t the soil teCtur)l cl)ss o2 eCperiment)l site w)s 2!D silt- &1D cl)5)nd 2&D s)nd (?)ble 1). ?hus- the teCture o2 the soil w)s cl)5)ccording to teCtur)l cl)ssi2ic)tion s5stem F1"G. ?he teCture indic)tes the degree o2 we)thering- nutrient-)nd w)ter holding c)p)cit5 o2 the soil. >urthermore- the cl)5 soil teCture w)s suit)ble 2or pot)to)nd other m)jor crops production due to its good)bilit5 to ret)in nutrients)nd)3)il)ble w)ter. 4owe3er- cl)5 soil h)s) high proportion o2 cl)5 p)rticles. #t is the c)useIs two biggest dr)wb)c;s o2 soils)s it swells when wet)nd cre)ting di22icult5 to till (he)35 o2 soils))nd cr)c;s when dr5 eCposing the roots to the)tmospheric elements F1"G.

?he p4 o2 the soil w)s)lmost slightl5)cidic (.2E)-)ccording to the r)ting o2 F19G. ?his 3)lue 2)lls in the p4 r)nge th)t w)s 3er5 conduci3e 2or pot)to production)s norm)l optimum soil p4 2or production is 2rom &.2 - .& F20G. /)tion 0Cch)nge /)p)cit5 (/0/) o2 the soil w)s (!3."2 meB/100g) which w)s 3er5 high)ccording to the r)ting o2 F21G. ?here2ore- there could be no limit)tion to the growth o2 the pot)to crop in terms o2 this soil /0/. ?he tot)l soil nitrogen content o2 eCperiment)l soil w)s 0.1&D which is moder)te)ccording to F21G.

?he)3)il)ble phosphorus content o2 the soil w)s medium (10.E9 ppm) in)ccord)nce with the r)ting o2 F22G. 'ot)to needs) good suppl5 o2 re)dil5)3)il)ble phosphorus since the root s5stem is not eCtensi3e)nd does not re)dil5 utili9e less)3)il)ble ' 2orms.

*3)il)ble sul2ur (10.EE ppm))nd boron (0. 0 ppm) were low)ccording to r)ting sc)le F23G. ?hus-)ccording to the soil l)bor)tor5 results- the soil o2 the stud5)re) w)s suit)ble 2or the production o2 pot)toes)nd other crops.

Table 1. *Physical and chemical properties of the experimental site before-planting at Oda bultum district during in, 2018.*

1. Properties (%)	Result	Rating	References
$)nd (D)	2&	-	-
$ilt (D)	2!	-	-
/l)5 (D)	&1	-	-
?eCtur)l /l)ss	/l)5	-	(6$1*- 19"E)
2. /hemic)l properties			
p4 (1: 2.& 4$_2$()	.2E	$lightl5)cidic	?e;)lign (1991)
(rg)nic .)tter /(./ (D)	3.00	. edium	?e;)lign (1991)
(rg)nic /)rbon /(// (D)	1.E!	. edium	?e;)lign (1991)
/)rbon-%itrogen r)tio (/: %)	9.1	Aer5 low	%ewe5 (200)
/0/ (meB/100 g soil)	!3."2	Aer5 high	. urph5 (200E)
?ot)l %itrogen /?%/ (D)	0.1&	. edium	. urph5 (19 ")
*3)il)ble 'hosphorus /'/(ppm)	10.E9	. edium	/ottenie (19"0)
*3)il)ble $ul2ur /$/(ppm)	10.EE	@ow	0thio$#$ (201!)
*3)il)ble =oron /=/(ppm)	0.0	@ow	0thio$#$ (201!)

3.2. Phenology and Growth of Potato

Phenology of potato traits

1)5s to &0D tubers emergence w)s signi2ic)ntl5 ('O0.0&) in2luenced b5 3)riet5- while the two m)in 2)ctors 3i9. 3)riet5)nd blended %'$= 2ertili9er h)d highl5 signi2ic)nt ('O0.01) e22ect on d)5s to &0D 2lowering)nd d)5s to 90D m)turit5. ?he inter)ction o2 3)riet5)nd blended %'$= 2ertili9er h)d) non-signi2ic)nt e22ect on phenolog5 o2 pot)to (?)ble 2).

=ubu h)d l)te emergence o2 tubers which too;)3er)ge d)5s o2 12.33)2ter pl)nting. ?his 3)riet5)lso h)d signi2ic)ntl5 del)5ed d)5s to &0D 2lowering (&2.& d)5s)2ter pl)nting))nd m)turit5 (10".E2 d)5s)2ter pl)nting) th)n 8ud)nie 3)riet5. 0)rl5 2lowering (&0.33 d)5s)2ter pl)nting) o2 the crop w)s obser3ed in the plot which did not recei3e 2ertili9er while the)pplic)tion o2 %'$= 2ertili9er del)5ed both the 2lowering)nd m)turit5 o2 the crop. ?he del)5ed 2lowering o2 pot)to w)s obser3ed in plots which recei3ed 300- 2&0)nd 100 ;g h)$^{-1}$ %'$= o2 2ertili9er with non-signi2ic)nt di22erences)mong the tre)tments e22ects. 'l)nts in plots which did not recei3e 2ertili9er)nd 100 ;g h)$^{-1}$ %'$= 2ertili9er showed e)rliness o2 crop m)turit5 while pl)nts in)ll other plots th)t recei3ed (1&0- 200- 2&0)nd 300 ;g h)$^{-1}$ %'$=) showed del)5ed m)turit5 (?)ble 2). ?his m)5 be rel)ted to the)3)il)bilit5 o2 % 2ound in the soil)nd th)t m)5 not show more di22erence)mong the tre)tments.

?he di22erence in emergence)nd &0D d)5s to 2lowering)nd d)5s to 90D m)turit5)mong the 3)rieties m)5 be eCpl)ined b5 di22erences in the genetic ch)r)cteristics. ?his suggestion supported b5 who reported) signi2ic)nt di22erence between 8ud)nie- =elete)nd L)lenie 3)rieties 2or d)5s to &0D

emergence o2 pl)nts)t 1eg)m F2!G. $imil)r reported shown th)t incre)sing)pplic)tion 2rom 0 to 3&0 ;g %'$= h)$^{-1}$ did not show signi2ic)ntl5 di22erence on &0D d)5s to emergence o2 pot)to F2!G. ?he signi2ic)nt di22erence between two pot)to 3)rieties 2or 2lowering)nd m)turit5 might be eCpl)ined b5 di22erences in the genetic ch)r)cteristics. ?his suggestion supported b5 who reported th)t 8ud)nie 3)riet5 w)s e)rl5 to m)ture)s comp)red to =ubu)nd =elete 3)rieties F2!G.

?he signi2ic)nt e22ect o2 higher r)tes o2 %'$= 2ertili9er on del)5ed 2lowering o2 pot)to)nd the obser3ed trend o2 del)5ed m)turit5 tow)rds the)pplic)tion o2 higher r)tes o2 %'$= 2ertili9er might be due to su22icient suppl5 o2 nutrient th)t promotes 3eget)ti3e growth)nd del)5ed the crop in)tt)ining reproducti3e st)ge. ?hese results)re in)greement with- who reported th)t)pplic)tion o2 %'$ 2ertili9ers del)5ed 2lowering st)ge F2 - 2!G. #n)ddition to these results- reported th)t incre)sed phosphorus)pplic)tion prolonged the d)5s to &0D 2lowering F2&G. >urthermore-)pplic)tion o2 nitrogen 2ertili9er)t higher r)tes enh)nced 3eget)ti3e growth b5 helping the pl)nt to)bsorb sunlight)nd produce c)rboh5dr)tes- but del)5ed the production o2 reproducti3e p)rt)nd thereb5 m)turit5 F2 G.

Table 2. *Effects of variety and blended NPSB fertilizer rates on the phenology of potato at Oda bultum distrct during 2018.*

Treatment	Traits		
Variety	**Days to 50% emergence**	**Days to 50% flowering**	**Days to 90% maturity**
=ubu	12.33$^{)}$	&2.&0$^{)}$	10".E2$^{)}$
8ud)nie	11.&0^{b}	&1.22^{b}	10&.&"^{b}
@$1 (&D)	0.3E	0.E2	0."1
%'$= 2ertili9er (;g h)$^{-1}$)			
0	12.1	&0.33^{d}	10&.10^{c}
100	12.00	&1. E^{bc}	10 .21$^{)b}$
1&0	11.&0	&1."3$^{)bc}$	10E.20^{bc}
200	12.00	&1.&0^{cd}	10".01$^{)}$
2&0	11."3	&2."3$^{)b}$	10".13$^{)}$
300	12.00	&3.00$^{)}$	10".&1$^{)}$
@$1 (&D)	%$	1.2&	1.!1
/A (D)	!. 3	2.0"	1.1

. e)ns within column 2ollowed b5 the s)me letter (s))re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd /A (D) P /oe22icient o2 3)ri)tion in percent

3.3. Growth of Potato Crop

Plant height and number of main stem

?he 3)riet5)nd %'$= 2ertili9er h)d signi2ic)nt (' O0.01) m)in e22ect on pl)nt height)nd number o2 m)in stem per hill. 4owe3er- the inter)ction e22ect o2 the two 2)ctors w)s not signi2ic)nt on pl)nt height)nd m)in stem number (?)ble 3).

=ubu 3)riet5 h)d t)ll pl)nts (2.!! cm))nd higher number o2 m)in stems per hill (.E") th)n 8ud)nie 3)riet5. @i;ewise- =elete (.&2))nd 8ud)nie (."9) produced) signi2ic)ntl5 di22erent number o2 m)in stems per hill F2&G. ?he di22erences between 3)rieties 2or pl)nt heights)nd number o2 m)in stems could be)ttributed b5 di22erences in genetic constitution o2 the 3)rieties. #n)ddition- the di22erence in pl)nt height)nd m)in stem number)mong the 3)rieties might be due to the inherent genot5pic 3)ri)tion F2EG.

#ncre)sing the r)te o2 %'$= 2ertili9er incre)sed pl)nt height)nd m)in stem number per hill line)rl5. *pplic)tion o2 200- 2&0)nd 300 ;g %'$= h)$^{-1}$ 2ertili9er r)tes resulted in signi2ic)ntl5 higher pl)nt height)nd m)in stem number. #ncre)sing the r)te o2 the 2ertili9er)pplic)tion 2rom 0 to 300 ;g %'$= h)$^{-1}$ incre)sed the pl)nt height)nd o2 m)in stems number per hill b5 1".&"D)nd 100D- respecti3el5 (?)ble 3). ?he highest pl)nt height (!."3cm))nd m)in stem number (".33 hill^{-1}) were obt)ined 2rom the)pplic)tion o2 300 ;g h)$^{-1}$ %'$= 2ertili9er while the shortest pl)nts (&!. Ecm))nd m)in stem number (!.1 hill^{-1}) were registered)t the un2ertili9ed plot. 4owe3er- the me)n o2 pl)nt height)nd m)in stem number were not st)tistic)ll5 di22erent)mong tre)tments 200- 2&0)nd 300 ;g h)$^{-1}$ %'$= 2ertili9er)pplic)tion this might be due to e22ect o2 % 2ound in the soil which did not showed 3)ries)mong the tre)tment.

?he signi2ic)ntl5 t)llest pl)nts)nd highest number o2 m)in stems were obser3ed tow)rds the)pplic)tion o2 higher r)tes o2 %'$= 2ertili9er th)t might be)scribed to the incre)sed)3)il)bilit5 o2 nitrogen in the soil 2or upt);e b5 pl)nt roots- which might h)3e su22icientl5 enh)nced 3eget)ti3e growth through incre)sing cell di3ision)nd elong)tion. . oreo3er- other studied reported th)t pl)nt height is incre)sed with incre)sing)pplic)tion o2 %'$= 2ertili9er 2rom 0 to 3&0 ;g h)$^{-1}$ F2!G. ?his might be presence o2 boron in the blended 2ertili9er nutrient source might signi2ic)ntl5 incre)sed pl)nt height due to its import)nt role in the cell di3ision)nd nitrogen)bsorption 2rom the soil- enh)ncing pl)nt growth ultim)tel5 incre)sed pl)nt height. $imil)rl5- other rese)rch wor; reported th)t incre)sing the r)te o2 phosphorus 2rom nil to 230 ;g '$_{2}$($_{&}$ h)$^{-1}$ resulted in highl5 signi2ic)nt incre)ses in pl)nt height F2"G. #t might be the presence o2 boron)nd sul2ur in the blended 2ertili9er nutrient source)lso signi2ic)ntl5 incre)sed pl)nt height due to its import)nt role in the cell di3ision)nd nitrogen)bsorption 2rom the soil- enh)ncing pl)nt growth ultim)tel5 incre)sed pl)nt height.

#n)ddition to these- the current in3estig)tion is)lso consistent with the other 2indings reported th)t signi2ic)ntl5 incre)sed stem number per hill with incre)sing the le3el o2 lime)nd %'$ 2ertili9er)pplic)tion F29G. . oreo3er- incre)sing)pplic)tion o2 %'$= 2ertili9er r)tes 2rom 0 to 3&0 ;g %'$= h)$^{-1}$ w)s incre)sed the m)in stem number o2 pot)to

2rom !.99 to .!" per hill- F2!G. ?his might be rel)ted to the 2)ct th)t) s5nergistic e22ect o2 the combined)pplic)tion o2 %)nd ' promoting good root s5stem- strong stem)nd good growth.

Table 3. *Effects of varieties and NPSB fertilizers on potato plant height and number of main stems, at Oda bultum distrct in 2018.*

Treatment	**Traits**	
Varieties	**Plant height (cm)**	**Main stem number (hill^{-1})**
=ubu	2.!!$^{)}$	.E"$^{)}$
8ud)nie	&".92^{b}	.0 ^{b}
@$1 (&D)	1.1&	0.!1
%'$= 2ertili9er (;g h)$^{-1}$)		
0	&!. E^{d}	!.1 ^{c}
100	&".&"^{cd}	&.32^{b}
1&0	0. E^{bc}	&.33^{b}
200	1.0E$^{)bc}$	E. !$^{)}$
2&0	3. E$^{)b}$	E. $^{)}$
300	!."3$^{)}$	".33$^{)}$
@$1 (&D)	!.0"	0.E2
/A (D)	&.3	".

. e)ns within column 2ollowed b5 the s)me letter (s))re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd /A (D) P /oe22icient o2 3)ri)tion in percent

3.4. Yield Components and Tuber Yield

Total tuber number and average tuber weight

?he)n)l5sis o2 3)ri)nce showed th)t the m)in e22ect o2 blended %'$= 2ertili9er)nd 3)riet5)nd their inter)ction e22ect h)d) signi2ic)nt e22ect (pO0.01) on tot)l tuber number per hill)nd)3er)ge tuber weight (?)ble !).

?he tot)l tuber number per hill)nd)3er)ge tuber weight (g tuber^{-1}) were incre)sed with incre)sing r)tes o2 %'$= 2rom 9ero to 200)nd 0 to 300 ;g h)$^{-1}$ 2or both pot)to 3)rieties- respecti3el5 (?)ble !). 4owe3er- incre)sing the %'$= suppl5 be5ond 200 ;g %'$= le3el did not signi2ic)ntl5 in2luence the tot)l tuber numbers per hill produced b5 the pot)to crop. $imil)rl5- in both 3)rieties- the lowest tot)l tuber number per hill w)s obt)ined 2rom plots th)t did not recei3e 2ertili9er. ?he highest tot)l tuber number per hill (1 .00 hill^{-1}))nd tuber weight (E2.33g tuber^{-1}) were obt)ined 2rom the tre)tment combin)tion o2 3)rieties 8ud)nie)nd =ubu 2or the)pplic)tion o2 200 ;g)nd 300 ;g %'$= h)$^{-1}$ r)te- respecti3el5 (?)ble !). 4owe3er- the lowest tot)l tuber number per hill (E."E tuber hill^{-1}) w)s recorded 2rom =ubu 3)riet5 with the un2ertili9ed plot.

?he results indic)ted th)t optimum r)te o2 %'$= 2or m)Cimum tot)l tuber number w)s)tt)ined)t 200 ;g %'$= h)$^{-1}$ 2or 8ud)nie)nd thus it w)s not)gronomic)ll5 necess)r5)nd bene2ici)l to incre)se the r)te o2 the 2ertili9er 2urther. >urthermore- this m)5 be indic)ted th)t the incre)sed % r)te might h)3e)n inhibitor5 e22ect on tuber initi)tion process which incre)sed h)ulm de3elopment but reduced tuber initi)tion. ?here2ore- results o2 the present stud5 cle)rl5 indic)ted th)t incre)sing pot)to tuber number)nd me)n tuber weights o2 pot)to 3)rieties is possible up to cert)in le3el o2 %'$= 2ertili9er)pplic)tion r)te.

8ener)ll5- the)3er)ge tuber weight o2 pot)to incre)sed)s the r)te o2 %'$= 2ertili9er incre)sed. 4owe3er- the m)Cimum tot)l tuber number per hill w)s)tt)ined up to 200 ;g %'$= h)$^{-1}$. ?he results o2 this stud5 showed th)t the import)nce o2 %'$=)pplic)tion to m)Cimi9e the tot)l tuber number per hill should be ;ept)t) moder)te r)ther th)n)t high r)tes. ?his result is in line with the other studied noted th)t the highest tot)l tuber number per hill w)s obt)ined 2rom 2&0 ;g %'$= h)$^{-1}$ F2!G. $imil)rl5- incre)sing the r)te o2 the blended %'$ 2ertili9er)pplic)tion 2rom nil to 100 ;g h)$^{-1}$ signi2ic)ntl5 incre)sed the tot)l tuber number per hill b5)bout 23D F2&G. ?he increment o2)3er)ge tuber weight in response to the incre)sed suppl5 o2 blended %'$= 2ertili9er might be due to more 2)st growth- more 2oli)ge)nd incre)se in le)2)re) due to) higher suppl5 o2 phosphorous cont)ining 2ertili9er which m)5 h)3e induced the 2orm)tion o2 bigger tubers thereb5 resulting in higher)3er)ge tuber weight.

Table 4. *Interaction effects of variety and blended NPSB fertilizer rates on total tuber number per hill and average tuber weight of potato at Oda bultum distrct, during in 2018.*

Blended NPSB fertilizer (kg ha^{-1})	**Total tuber number (tuber hill^{-1})**		**Average tuber weight (g tuber^{-1})**	
	Varieties			
	Bubu	**Gudanie**	**Bubu**	**Gudanie**
0	E."E^{e}	10.20^{d}	& .00^{d}	!!. E^{d}
100	10.00^{d}	12.20^{c}	1.00^{c}	&9.0E^{cd}
1&0	12.33^{c}	12.20^{c}	3.29^{bc}	1.00^{c}
200	1!.0 ^{b}	1 .00$^{)}$	E.33^{b}	.00^{b}
2&0	13.!0^{bc}	13.20^{bc}	E."3$^{)b}$	.3E^{b}
300	13.13^{bc}	13.0! ^{bc}	E2.33$^{)}$	. E^{b}
@$1 (&D) /A (D)	1.&" E. 1		!.E3 !.&2	

. e)ns within column)nd rows o2 e)ch tr)its 2ollowed b5 the s)me letter)re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd /A (D) P /oe22icient o2 3)ri)tion in percent

Distribution of tubers into size categories

*n)l5sis o2 3)ri)nces re3e)led th)t percent)ge o2 sm)ll)nd medium tuber si9e were signi2ic)ntl5 (pO0.01) b5 the m)in e22ect o2 3)riet5)nd %'$= 2ertili9er- while l)rge tuber si9e did not)22ected b5 the m)in e22ect o2 3)riet5- while the inter)ction o2 both 2)ctors is non-signi2ic)nt on)ll tuber si9e proportion (?)ble &). >rom the m)in 2)ctors- =ubu 3)riet5 h)d the highest medium)nd l)rge tuber si9e w)s recorded with 3E.2ED)nd 31.9 D- respecti3el5. <here)s- the highest sm)ll tuber si9e (3&.3&g tuber^{-1}) w)s produced b5 the 3)riet5 8ud)nie. ?his m)5 be due to the higher number o2 tubers)s well)s ch)r)cteristics o2 3)riet5)d)pt)bilit5 or est)blishment e22ects o2 the other growth)ttributes. ?his stud5 is in)greement with other rese)rch reported th)t the lowest 3)lue w)s obt)ined 2rom =ubu 3)riet5 F30G.

?he proportion o2 sm)ll-si9ed pot)to tubers signi2ic)ntl5 decre)sed b5 &3. E to 19.9!D with incre)sing r)tes o2 the use o2 miner)l 0 to 300 ;g %'$= h)$^{-1}$ 2ertili9ers- respecti3el5. ?hus- incre)sing)pplic)tion o2 blended %'$= 2ertili9er 2rom 0 to 2&0)nd 0 to 300 ;g h)$^{-1}$ signi2ic)ntl5 incre)sed the percent)ge o2 medium)nd l)rge tuber si9e 2rom 29."3 to !2.9ED)nd 1 .&0 to 39."ED- respecti3el5 (?)ble "). (n the other h)nd- incre)sing)pplic)tion o2 blended %'$= 2ertili9er 2rom 0 to 2&0)nd 0 to 300 ;g h)$^{-1}$ signi2ic)ntl5 incre)sed the percent)ge o2 medium)nd l)rge tuber si9e b5)bout !!D)nd 1!1. 3D- respecti3el5. 4owe3er-)t higher r)tes o2 200- 2&0)nd 300 ;g %'$= h)$^{-1}$ 2ertili9er)pplic)tion did not signi2ic)nt di22erences obser3ed in the proportion o2 medium)nd l)rge-si9ed tubers. =ut there is no st)tistic)l di22erence 2rom 200 to 300 ;g %'$= h)$^{-1}$ (?)ble &). ?his shows th)t incre)sing the r)te o2 %'$= did not 3igorousl5)22ect this p)r)meter o2 the pl)nt.

?he result is in)greement with other studied who h)3e demonstr)ted th)t incre)sed phosphorus)pplic)tion 2rom ! to 13" '2(& ;g h)$^{-1}$ incre)sed the proportion o2 l)rge)nd medium-si9ed tubers produced in the r)nge between !9.!2 to &3.E2D)nd 3 . 2 to !1.2 D- respecti3el5 F31G. >urthermore- other schol)rs obser3ed th)t the l)rgest proportion o2 sm)ll-si9ed tubers w)s obt)ined)t the)pplic)tion o2 un2ertili9ed plots. . oreo3er- other schol)r obser3ed 3!.32 to 3E.&3D incre)se o2 medium si9e tubers o2 pot)to)s the %'$=)pplic)tion incre)sed 2rom 0 to 200 ;g h)$^{-1}$ F12G. ?he impro3ement in the si9e o2 the pot)to tubers in response to the)pplic)tion o2 2ertili9ers could be)scribed to impro3ed nutrient st)tus)nd ph5sicochemic)l propert5 o2 the soil in the)re).

Table 5. *Main effects of variety and NPSB fertilizer rates on tuber size proportion of potato grown at Oda bultum during 2018.*

Treatment	**Traits**		
Variety	**Small tuber size (%)**	**Medium tuber size (%)**	**Large tuber size (%)**
=ubu	30.EE^{b}	3E.2E$^{)}$	31.9
8ud)nie	3&.3&$^{)}$	3!."9^{b}	29.EE
@$1 (&D)	3.02	2.21	%$
%'$= 2ertili9er (;g h)$^{-1}$)			
0	&3. E$^{)}$	29."3^{d}	1 .&0^{c}
100	!2.99^{b}	30.2"^{d}	2 .E!^{b}
1&0	3 .19^{c}	3!."3^{c}	2".9"^{b}
200	2!. ^{d}	3".3&^{bc}	3 .13$^{)}$
2&0	20.91^{d}	!2.9E$^{)}$	3 .99$^{)}$
300	19.9!^{d}	!0.20$^{)b}$	39."E$^{)}$
@$1 (&D)	&.23	3."2	&.32
/A (D)	13.!	9.0	1!.

. e)ns within column 2ollowed b5 the s)me letter (s))re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd /A (D) P /oe22icient o2 3)ri)tion in percent

Marketable, unmarketable tuber number and Unmarketable tuber yield

.)r;et)ble tuber number w)s signi2ic)ntl5 (' O 0.01) in2luenced b5 the m)in e22ects o2 3)riet5)nd %'$= 2ertili9er- but not b5 their inter)ction e22ect (?)ble). 6nm)r;et)ble tuber number hill^{-1} signi2ic)ntl5 (' O 0.01) in2luenced b5 %'$= 2ertili9er- but the m)in e22ect o2 3)riet5 did not show signi2ic)nce in2luence on unm)r;et)ble tuber number.

8ud)nie h)d higher m)r;et)ble)nd unm)r;et)ble tuber number o2 9.3)nd 3.3& tuber hill^{-1}- respecti3el5 (?)ble). ?his m)5 be due to genetic di22erences between the 3)rieties in photos5nthesis)nd dr5 m)tter)ccumul)tion. (ther report indic)ted th)t genetic di22erences)mong pot)to 3)rieties pl)5) role in their)bilit5 to produce high solids F32G.

.)r;et)ble tuber number w)s incre)sed up to 200 ;g %'$= h)$^{-1}$ r)te)nd be5ond it w)s decre)sed. <here)s the trend o2 unm)r;et)ble tuber w)s in opposite direction to)s incre)sing)pplic)tion o2 %'$= 2ertili9er which decre)sed 2rom 9ero to 300 ;g %'$= h)$^{-1}$ 2ertili9er)pplic)tion. #ncre)sing the r)te o2 the 2ertili9er)pplic)tion 2rom 0 to 200 ;g %'$= h)$^{-1}$- incre)sed m)r;et)ble tuber number b5)bout 130D- howe3er- unm)r;et)ble tuber number w)s decre)sed b5 39.1 D. ?he highest m)r;et)ble tuber numbers (12.0" tuber hill^{-1}) w)s obt)ined)t 200 ;g %'$= h)$^{-1}$. <here)s- the lowest unm)r;et)ble number (2." tuber hill^{-1}) w)s obt)ined 2or the)pplic)tion o2 300 ;g %'$= h)$^{-1}$ (?)ble). <here)s- the lowest m)r;et)ble tuber number (&.0& tuber hill^{-1}) w)s recorded 2orm un2ertili9ed plot.

?he highest m)r;et)ble tuber numbers obt)ined b5)pplic)tion o2 higher r)te 2ertili9er might be the higher r)te o2 nitrogen bec)use nitrogen c)n)cti3)te the 3eget)ti3e growth de3elopment)nd)lso)ssoci)ted with) decre)se in the number o2 sm)ll si9e tubers due to incre)se in the weight o2 indi3idu)l tubers. #n)ddition to other studied reported th)t the)pplic)tion o2 %'$= 2ertili9er 2rom 0 to 3&0 ;g %'$= h)$^{-1}$ incre)sed the number o2 m)r;et)ble tuber b5 ! D F2!G. ?he high)nd lowest number o2 unm)r;et)ble tubers w)s obser3ed 2or the control tre)tment)nd highest r)tes o2 2ertili9er)pplic)tion- respecti3el5. ?his m)5 be due to the phenomenon th)t phosphorus incre)sed the)bo3e-ground biom)ss 3i) photos5nthesis)nd net)ssimil)tion processes)nd no re-)bsorption e3identl5 too; pl)ce 2rom the tubers- le)ding to incre)sed tuber si9e)nd weight so the tuber could be m)r;et)ble.

Table 6. *Effects of variety and blended NPSB fertilizer rates on yield components at Oda bultum distrct, in 2018.*

Treatment	Traits		
Variety	**Marketable tuber number (tuber hill^{-1})**	**Unmarketable tuber number (tuber hill^{-1})**	**Unmarketable tuber yield (t ha^{-1})**
=ubu	".&1^{b}	3.31	3.1E^{b}
8ud)nie	9.3 $^{)}$	3.&9	3. $^{")}$
@$1 (&D)	0. &	%$	0.3"
%'$= 2ertili9er (;g h)$^{-1}$)			
0	&.0&^{e}	3.9"$^{)}$	!.3"$^{)}$
100	E.1 ^{d}	3.9 $^{)}$	3.9 $^{)}$
1&0	". 0^{c}	3."3$^{)}$	3.9&$^{)}$
200	12.0"$^{)}$	3.0&^{b}	3.00^{b}
2&0	10.3 ^{b}	2.9"^{b}	2.9&^{bc}
300	10.31^{b}	2." ^{b}	2.30^{c}
@$1 (&D)	1.13	0.E0	0.
/A (D)	10.E	1E.3	1 .!&

. e)ns within column)nd rows o2 e)ch tr)its 2ollowed b5 the s)me letter (s))re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd /A (D) P /oe22icient o2 3)ri)tion in percent

A)riet5- =ubu h)d the lowest unm)r;et)ble tuber 5ield (3.1E t h)$^{-1}$)- while 8ud)nie 3)riet5 h)d the highest unm)r;et)ble tuber 5ield (3. " t h)$^{-1}$). ?he signi2ic)nt di22erence between 3)rieties 2or unm)r;et)ble 5ield m)5 be due to)d)pt)bilit5- crop m)turit5-)nd the inherent)bilit5 o2 pot)to 3)rieties in producing unm)r;et)ble tubers per pl)nt. $imil)rl5- other studied reported th)t 8ud)nie)nd L)lenie 3)rieties produced signi2ic)ntl5 higher unm)r;et)ble tuber 5ield F33G. >urthermore- incre)sing %'$= blended 2ertili9er 2rom 0 to 300 ;g %'$= h)$^{-1}$ decre)sed unm)r;et)ble tuber 5ield 2rom !.3" to 2.30 t h)$^{-1}$. ?he highest unm)r;et)ble tuber 5ield (!.3" t h)$^{-1}$) w)s obt)ined 2rom control plot (no 2ertili9er)pplied) which w)s p)r with 100)nd 200 ;g h)$^{-1}$ %'$= 2ertili9er)pplied- where)s the lowest unm)r;et)ble tuber 5ield (2.30 t h)$^{-1}$) w)s recorded 2rom plot tre)ted b5 300 ;g %'$= h)$^{-1}$)nd it w)s st)tistic)ll5 p)r with 2&0 ;g %'$= h)$^{-1}$ (?)ble).

. oreo3er- 3)riet5)nd nitrogen h)d) signi2ic)nt e22ect on unm)r;et)ble tuber 5ield o2 pot)to th)t incre)sing the nitrogen le3el decre)sed the unm)r;et)ble tuber weight up to 100 ;g % h)$^{-1}$ F3!G. $imil)rl5- other stud5 reported th)t incre)sing the r)te o2 blended %'$ 2ertili9er 2rom nil to 100 ;g h)$^{-1}$ signi2ic)ntl5 decre)sed the unm)r;et)ble tuber 5ield F2&G.

3.5. Tuber Yields

.)r;et)ble)nd tot)l tuber 5ields

?he)n)l5sis o2 3)ri)nce showed th)t the m)in e22ect o2 blended %'$= 2ertili9er)nd 3)riet5-)s well)s their inter)ction h)d signi2ic)ntl5 ('O 0.0&) in2luenced m)r;et)ble)nd tot)l tuber 5ields (?)ble E). 4owe3er- unm)r;et)ble tuber 5ield o2 pot)to w)s signi2ic)ntl5 (' O 0.01) in2luenced b5 the m)in e22ect o2 3)riet5)nd 2ertili9er but not b5 their inter)ction.

#ncre)sing the r)te o2 blended %'$= 2ertili9er 2rom nil to 200 ;g h)$^{-1}$ incre)sed m)r;et)ble)nd tot)l tuber 5ield. ?he)pplic)tion o2 blended %'$= 2ertili9er incre)sed m)r;et)ble)nd tot)l tuber 5ield (ton h)$^{-1}$) in both pot)to 3)rieties)s comp)red to growing o2 3)rieties without 2ertili9er)pplic)tion. #ncre)sing blended %'$= 2ertili9er r)tes 2rom 0 to 200 ;g h)$^{-1}$ incre)sed m)r;et)ble tuber 5ield o2 =ubu)nd 8ud)nie b5)bout E."3)nd 11."9 t h)$^{-1}$- respecti3el5- where)s- it incre)sed tot)l tuber 5ield o2 =ubu)nd 8ud)nie E.E3)nd 10.22 t h)$^{-1}$- respecti3el5 (?)ble E). #ncre)sing the r)te o2 the 2ertili9er)pplic)tion be5ond 200 ;g h)$^{-1}$ did not signi2ic)ntl5 incre)se the m)r;et)ble)nd tot)l tuber 5ields o2 both 3)rieties. ?hus the highest signi2ic)nt m)r;et)ble 5ield (2E.22 t h)$^{-1}$))nd tot)l tuber 5ield (30.&& t h)$^{-1}$) were recorded 2rom 8ud)nie 3)riet5)t 200 ;g %'$= h)$^{-1}$)pplic)tion- while- the lowest m)r;et)ble (1!. E t h)$^{-1}$))nd tot)l 5ield (1".!3 t h)$^{-1}$) were obt)ined 2rom un2ertili9ed plots o2 =ubu 3)riet5.

?he di22erence in 5ield)mong this 3)rieties)nd blended %'$= 2ertili9er might be rel)ted to their genetic m);eup in the e22icient utili9)tion o2 inputs li;e nutrients- which is one o2 the 2our m)jor c)tegories o2 the 2)ctors th)t)22ect 5ields (soil- clim)tic- genetic)nd m)n)gement pr)ctices) the r)te o2 nitrogen w)s incre)sed 2rom 100 to 1&0 ;g % h)$^{-1}$- the m)r;et)ble tuber 5ields o2 8ud)nie- L)lenie)nd Jengen) signi2ic)ntl5 incre)sed F3&G.

?he incre)se in tot)l tuber 5ield in response to the incre)sed)pplic)tion o2 the combined %'$= 2ertili9ers might be due to the incre)sed photos5nthetic)cti3it5)nd tr)nsloc)tion o2 photos5nthetic product to the root- which might h)3e helped in the initi)tion o2 more stolen on pot)to F3 G. $imil)rl5- the %'$=)pplic)tion be5ond 200 ;g h)$^{-1}$ did not bring signi2ic)nt 5ield)d3)nt)ge F12G. #n the current eCperiment- %'$=)pplic)tion be5ond 200 ;g h)$^{-1}$ did not bring signi2ic)nt 5ield)d3)nt)ged.

Table 7. Interaction effects of blended NPSB fertilizer and variety on marketable tuber yield and total tuber yield of potato at Oda bultum distrct during, in 2018.

Treatment NPSB fertilizer (kg ha^{-1})	Marketable tuber yield (t ha^{-1})		Total tuber yield (t ha^{-1})	
	Variety			
	Bubu	Gudanie	Bubu	Gudanie
0	1!. E^{d}	1&.33^{d}	1".!3^{2}	20.33^{e2}
100	1E.&0^{cd}	19.21^{bcd}	21.20^{de2}	23.!&^{bcde}
1&0	19.1 ^{bcd}	1"."0^{bcd}	21."2^{cde2}	23.03^{bcde}
200	22.!9^{b}	2E.22$^{)}$	2 .1 ^{b}	30.&&$^{)}$
2&0	22.&0^{b}	23.12$^{)b}$	2&.00^{bcd}	2&."9^{bc}
300	21.33^{bc}	22.E2$^{)b}$	2!.0E^{bcde}	2&.22^{bcd}
@$1 (&D)	!.&&		!.1"	
/ A	13.2		10.!	

. e)ns within column)nd rows o2) 3)ri)ble 2ollowed b5 the s)me letter)re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd / A (D) P / oe22icient o2 3)ri)tion in percent

3.6. Tuber Quality Related Parameters

?he 3)riet5)nd %'$= 2ertili9er h)d signi2ic)nt ('O0.0&) e22ect on speci2ic gr)3it5- tuber dr5 m)tter)nd st)rch contents o2 pot)to. 4owe3er- the inter)ction e22ect o2 blended %'$= 2ertili9er)nd 3)riet5 did not show signi2ic)nt e22ects on)ll tuber Bu)lit5 rel)ted tr)its (?)ble "). >rom the m)in e22ect o2 3)riet5- the higher speci2ic gr)3it5 (1.0"&)- tuber dr5 m)tter content (21.9"D))nd tuber st)rch content (1&."2g/100g) were me)sured 2rom 8ud)nie th)n =ubu 3)riet5 (?)ble ").

#ncre)sing the r)tes o2 %'$= 2ertili9er)pplic)tion 2rom 0 to 200 ;g h)$^{-1}$ incre)sed the speci2ic gr)3it5- tuber dr5 m)tter content)nd tuber st)rch content- howe3er- the inter)ction e22ect o2 blended %'$= 2ertili9er)nd 3)riet5 did not show signi2ic)nt e22ects on)ll tuber Bu)lit5 rel)ted tr)its (?)ble ")- while 2urther incre)se in the 2ertili9er r)te did not bring) signi2ic)nt incre)se in these tr)its. $imil)rl5- tuber st)rch content o2 the pot)to signi2ic)ntl5 impro3ed b5 incre)sed %'$= 2rom 0 to 100 ;g h)$^{-1}$- while be5ond this r)te the e22ect w)s non-signi2ic)nt.

Table 8. The main effect of varieties and blended NPSB fertilizers rates on specific gravity, tuber dry matter content and starch content of the potato at Oda bultum distrct during 2018.

Treatment	Traits		
Varieties	Specific gravity of tuber (g/cm^{3})	Tuber dry matter content (%)	Tuber starch content (g/100g)
=ubu	1.0"1^{b}	21.20^{b}	1&.19^{b}
8ud)nie	1.0"&$^{)}$	21.9"$^{)}$	1&."2$^{)}$
@$1 (&D)	0.0020	0.E&	0. 1
%'$= 2ertili9er (;g h)$^{-1}$)			
0	1.0E ^{c}	20.1E^{d}	13. !^{b}
100	1.0"2^{b}	21.2E^{cd}	1&.29$^{)}$
1&0	1.0"E$^{)b}$	22. &$^{)b}$	1 .0!$^{)}$
200	1.0""$^{)}$	22.9 $^{)}$	1 .31$^{)}$
2&0	1.0" $^{)b}$	21."2$^{)bc}$	1&.92$^{)}$
300	1.0"&$^{)b}$	21.&"^{bc}	1&."2$^{)}$
@$1 (&D)	0.003&	1.30	1.0
/ A (D)	0.3	&.!2	&.

. e)ns with in column in e)ch tr)it)nd tre)tment 2ollowed b5 the s)me letter (s))re not signi2ic)ntl5 di22erent)t &D le3el o2 signi2ic)nce- @$1 (&D) P @e)st signi2ic)nt di22erence)t pP 0.0&)nd / A (D) P / oe22icient o2 3)ri)tion in percent

?he highest speci2ic gr)3it5 (1.0"")- tuber dr5 m)tter content (22.9 D))nd tuber st)rch content (1 .31g/100g) obt)ined 2rom 200 ;g %'$= h)$^{-1}$. 4owe3er- the lower speci2ic gr)3it5- tuber dr5 m)tter content)nd tuber st)rch content (1.0E)- (20.1ED))nd (13. !g/100g) were obt)ined 2rom the control plots- respecti3el5. (n the other h)nd- speci2ic gr)3it5)g)in re3erted to st)tistic)ll5 the s)me 3)lue)s obser3ed)t the 1&0 to 300 ;g %'$= h)$^{-1}$ 2ertili9er r)tes which c)n be prob)bl5)ssoci)ted with the incre)sed stored)ssimil)tes in pot)to tubers with higher r)tes o2 %'$= 2ertili9er. ?his m)5 be rel)ted to the)3)il)bilit5 o2 pl)nt nutrient %)nd ' 2ound in the soil which m)5 not)22ect strongl5 the tr)its.

. oreo3er- signi2ic)nt incre)se o2 speci2ic gr)3it5 o2 pot)to tubers with the incre)sed 2ertili9er r)tes- where)s)lso reported the highest speci2ic gr)3it5 o2 tuber (1.09!) o2 8ud)nie 3)riet5 due to the)pplic)tion o2 100 ;g %'$ h)$^{-1}$ 2ertili9er r)tes F22G. 4owe3er- this results dis)greement with other 2inding th)t speci2ic gr)3it5 w)s not signi2ic)ntl5)22ected b5 the)pplic)tion o2 blended %'$= 2ertili9er F2!G. ?here2ore- incre)sing the r)te o2 the miner)l 2ertili9er be5ond 200 ;g %'$= h)$^{-1}$ decre)sed tuber speci2ic gr)3it5. >urthermore- the speci2ic gr)3it5 o2 pot)to w)s highl5 signi2ic)ntl5 in2luenced b5 %'$ 2ertili9er r)tes.

?he highest tuber dr5 m)tter content (21.9"D) w)s recorded 2or 8ud)nie 3)riet5- while the lowest tuber dr5 m)tter (21.20D) w)s obt)ined 2rom =ubu 3)riet5. ?his might be due to the genetic di22erence between the 3)rieties. #n line with the result- =elete)nd 8ud)nie 3)rieties produced tubers with higher tuber dr5 m)tter content th)n =ubu 3)riet5 F30G.

?he incre)se o2 tuber dr5 m)tter with incre)sing up 200 ;g %'$=)pplic)tion r)tes obser3ed in the present stud5 is prob)bl5 the results o2)ccumul)tion)nd p)rtitioning o2 more)ssimil)tes in tubes)s indic)ted b5 the 2indings o2 3)rious rese)rchers F3"G. (n the s)me m)nner- the present 2inding is in)greement with other- stud5 reported th)t incre)sing)pplic)tion o2 blended 2ertili9ers o2 100D to 200D %'$= with %)djustment incre)sed tuber dr5 m)tter line)rl5)s comp)red to control tre)tment F2 G.

?he present result)ppe)red to be inconsistent with this 2inding o2 stud5 reported th)t the chemic)l constituents o2 pot)to tubers li;e st)rch contents were incre)sed with incre)sing the %'Q le3els F39G. #n gener)l- pot)to 3)rieties with) st)rch content o2 13D)nd)bo3e)re the most pre2erred 2or processed products F!OG

3.7. Partial Budget Analysis

?he result o2 the p)rti)l budget)n)l5sis re3e)led th)t the m)Cimum net bene2it o2 =irr 11 330.2! h)$^{-1}$ with)n)ccept)ble m)rgin)l r)te o2 returns (. ++) o2 !0 D w)s obt)ined 2rom 8ud)nie 3)riet5 th)t recei3ed the)pplic)tion o2 200 ;g h)$^{-1}$ blended %'$= 2ertili9er on (?)ble 9). ?he results o2 the stud5 indic)ted th)t 3)rieties)nd blended %'$= 2ertili9ers h)d gi3en promoting bene2it o3er the control. ?he)pplic)tion o2 blended %'$= 2ertili9er 2or the production o2 tubers 2rom both 3)rieties h)d . ++)bo3e 100D but the m)Cimum . ++ (D) w)s obt)ined 2rom 8ud)nie 2ollowed 2rom =ubu 3)riet5 with the)pplic)tion o2 200 ;g h)$^{-1}$ blended %'$= 2ertili9er.

=)sed on this result- 200 ;g blended %'$= h)$^{-1}$)nd 3)riet5 8ud)nie)nd =ubu resulted in highest)djust)ble m)r;et)ble tuber 5ield 2!.!9)nd 20.2! t h)$^{-1}$- respecti3el5 were pro2it)ble to the 2)rmers in the stud5)re). ?he identi2ic)tion o2) recommend)tion is b)sed on) ch)nge 2rom one tre)tment to)nother i2 the m)rgin)l r)te o2 return o2 th)t ch)nge is gre)ter th)n the minimum r)te o2 return. ?here2ore- the 8ud)nie 3)riet5)t di22erent r)tes o2 blended 2ertili9er meets the)ccept)ble minimum r)te o2 return to 2)rmersI recommend)tion through the best recommend)tion to m)Cimi9e the net bene2it to the 2)rmer; there2ore the highest net bene2it w)s recorded on 8ud)nie 3)riet5)t 200 ;g %'$= h)$^{-1}$.

Table 9. *Partial budget and marginal rate of return analysis for effects of blended NPSB fertilizer rates and varieties at at Oda bultum distrct during 2018 cropping season.*

No Trt	Blended NPSB (kg ha^{-1})	Variety	Unadjusted Mrkyld (t ha^{-1})	Adjusted Mrkyld (t ha^{-1})	Total variables Cost (ETB)	Gross Income (ETB)	Net Income (ETB)	MRR (%)
1	0	=	1!. E	13.20	1&"!	01&	2"! .	0
2	0	8	1&.33	13."0	1 &	"9"&	E329.!	0
3	100	=	1E.&0	1&.E&	3&00	E"E&0	E&2&0	&30
!	100	8	19.21	1E.29	3 "&	" !!&	"2E 0.3	!0
&	1&0	=	19.1	1E.2!	!3E9	" 220	"1"!0.E	1
	1&0	8	1"."0	1 .92	!3!0	"! 00	"02&9.	1
E	200	=	22.!9	20.2!	& !9	10120&	9&&& .1	11 9
"	200	8	2E.22	2!.&0	1 0	122!90	11 330	!0
9	2&0	=	22.&0	20.2&	1&!	1012&0	9&09 .!	1
10	2&0	8	23.12	20."1	30!	1022!0	9&93 .2	&&
11	300	=	21.33	19.20	E2 0	9&9E&	""E1&	1
12	300	8	22.E2	20.!&	E32E	10!0!0	9 E13	119!

<here- =lended %'$= cost P =irr 12. ;g^{-1} blended %'$=- blended %'$= 2ertili9ers)pplic)tion cost- =irr 3.& ;g^{-1} o2 blended %'$=- *pplic)tion cost o2 blended %'$= 2ertili9ers & persons 100 ;g h)$^{-1}$- e)ch E0 0?= d)5^{-1}- /ost o2 tuber 5ield tr)nsport)tion to the ne)r m)r;et 120 =irr ton^{-1})nd 'rice o2 tuber 5ield & =irr ;g^{-1}- . r;5ld P .)r;et)ble tuber 5ield- . ++ (D) P .)rgin)l r)te o2 return)nd 1P1omin)ted tre)tment- =P=ubu- 8P 8ud)nie.

4. Summary and Conclusion

?he results o2)n)l5sis o2 3)ri)nce indic)ted th)t 8ud)nie 3)riet5 too;) shorter time 2or tuber emergence- 2lowering)nd m)turit5 th)n =ubu 3)riet5. 8ud)nie 3)riet5 w)s grown with the)pplic)tion o2 200 ;g h)$^{-1}$)nd =ubu 3)riet5)t 300 ;g h)$^{-1}$ %'$= o2 2ertili9er produced signi2ic)ntl5 the highest tot)l number o2 tubers)nd)3er)ge tuber weight- respecti3el5. 8ud)nie 3)riet5 h)d signi2ic)ntl5 higher number o2 m)r;et)ble tuber (hill^{-1}). ?he)pplic)tion o2 200 ;g h)$^{-1}$ %'$= o2 2ertili9er produced signi2ic)ntl5 the highest number o2 m)r;et)ble tuber though me)n 3)lues h)d non-signi2ic)nt di22erence with the)pplic)tion o2 2&0)nd 300 ;g h)$^{-1}$ %'$= o2 2ertili9er.

?he highest m)r;et)ble tuber 5ield (2E.22 t h)$^{-1}$) w)s recorded 2or 8ud)nie in response to the)pplic)tion o2 200 ;g %'$= h)$^{-1}$)nd the lowest m)r;et)ble tuber 5ield (1!. E t h)$^{-1}$) w)s recorded 2or the =ubu 3)riet5 with no %'$= 2ertili9)tion. < ith the s)me trend- the highest tot)l tuber 5ield (30.&& t h)$^{-1}$) w)s recorded 2or 8ud)nie in response to the)pplic)tion o2 200 ;g %'$= h)$^{-1}$)nd the lowest tot)l tuber 5ield (1".!3 t h)$^{-1}$) w)s recorded 2or the =ubu 3)riet5 with no %'$= 2ertili9)tion.

?he)pplic)tion o2 200 ;g h)$^{-1}$ %'$= plus 100 ;g h)$^{-1}$ ure) 2ertili9er with the combin)tion o2 3)riet5 8ud)nie h)d produced highest me)n 3)lues 2or most o2 growth tr)its- 5ield components)nd tuber Bu)lit5 rel)ted tr)its. . oreo3er- the p)rti)l budget)n)l5sis re3e)led th)t the m)Cimum net bene2it o2 11 330.2! =irr h)$^{-1}$ with m)rgin)l r)te o2 returns (. ++) o2 !0 D w)s obt)ined 2rom the tre)tment combin)tion o2 8ud)nie 3)riet5)nd blended 200 ;g h)$^{-1}$ %'$= 2ertili9er)pplic)tion plus 100 ;g h)$^{-1}$ ure). ?here2ore- it c)n be concluded th)t 200 ;g h)$^{-1}$ blended %'$= 2ertili9er r)tes)nd 8ud)nie 3)riet5 c)n be pro3ision)ll5 recommended 2or pot)to growers in the stud5)re).

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F1G *d)ne 4irp)- . ir)nd)- '. . - *g)jie ?es2)5e- <illemien- L. . - @ommen- *l2ons (ude @)nsin;- *dm)su ?seg)5e)nd ')ul- /. $. 2010. *n)l5sis o2 seed pot)to s5stems in 0thiopi). *American Journal of Potato Research,* "E: &3E-&&2.

F2G . ond)l- . . *. *. 2003. #mpro3ement o2 pot)to (*Solanum tuberosum* @.) through h5bridi9)tion)nd *in vitro* culture techniBue. 'h1. * dissert)tion presented to +)jsh)hi 6ni3ersit5- +)jsh)hi- =)ngl)desh- p 2E0.

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F!G /$* (/entr)l $t)tistic)l *genc5 0thiopi)). 201". +eport on)re))nd production o2 m)jor crops. *gricultur)l s)mple sur3e5. *ddis *b)b) $t)tistic)l =ulletin- 1 (&"!)- 1!- ".

F&G >*($?*? (>ood)nd *griculture (rg)ni9)tion). 201E. *gricultur)l in the world top countr5 o2 pot)to producer)re))nd production o2 m)jor t)bles o2 /entr)l $t)tistic)l *genc5- *3)il)ble online)ccessed)t www.pot)to.org.

F G ?es2)5e *bebe)nd : ig9)w- 1es)legn. 200". +e3iew o2 crop impro3ement rese)rch)chie3ements)nd 2uture 2ocus in p)rts o2 western *mh)r) region: the c)se o2 *det. https://pd2s.sem)nticschol)r.org.

FEG . el;)mu *lem)5ehu- . inw5elet Lemberie. 201". (ptimum r)tes o2 %'$ 2ertili9er)pplic)tion 2or economic)ll5 pro2it)ble production o2 pot)to 3)rieties)t Qog) #rrig)tion $cheme- %orthwestern 0thiopi). *Cogent Food and Agriculture*- !: 1-1E.

F"G . ul)t 1eme;e- Qell5- A- L)5ne- ?. $- *li- $. @e- A)llee- L. /.)nd /hen- 4. 199". *gricultur)l m)r;et per2orm)nce)nd determin)nts o2 2ertiliser use in 0thiopi). pp. 1- 9. <or;ing p)per 10. 8r)in m)r;et rese)rch project. . inistr5 o2 0conomic 1e3elopment)nd /ooper)tion- *ddis *b)b)- 0thiopi).

F9G 4)3er;ort- *. L.- A)n Qoes3eld- . . L- $chepers- 4. ?. *. . - <ijn)nds- L. 4. . - <ustm)n- +.)nd Jh)ng- R. R. 2012. 'ot)to prospects 2or 0thiopi): on the ro)d to 3)lue)ddition (%o. &2"). ''(*8A.

F10G =iru; %)men). 201". 022ects o2 +)tes o2 =lended %'$=)nd %itrogen >ertili9ers on : ield)nd : ield /omponents o2 'ot)to (*Solanum tuberosum* @) #n 0)st =)d)w)cho 1istrict- $outhern 0thiopi). . $c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5)- 0thiopi).

F11G *l)m- . . %.- L)h)n- . . $. *li- . . Q. *shr)2- . . *.)nd #sl)m- . . 200E. 022ect o2 3ermicompost)nd chemic)l 2ertili9ers on growth- 5ield)nd 5ield components o2 pot)to in b)ring soils o2 =)ngl)desh. *Journal of Applied Sciences Research*- 3 (12): 1"E9-1""".

F12G <)ssie 4)ile)nd ?e;)lign .)mo. 2013. ?he 022ect o2 'ot)ssium on the : ields o2 'ot)to)nd <he)t grown on the *cidic $oils o2 /hench))nd 4)gere $el)m in $outhern 0thiopi). #ntern)tion)l 'ot)sh #nstitute- (3&)- pp. 3-".

F13G *?* (*gricultur)l ?r)ns2orm)tion *genc5). 201 . ?r)ns2orming the use o2 2ertili9er in 0thiopi): @)unching the n)tion)l 2ertili9er blending progr)m- *ddis *b)b).

F1!G /#' (#ntern)tion)l 'ot)to /enter). 200 . 'rocedures 2or st)nd)rd e3)lu)tion tri)ls o2)d3)nced pot)to clones. *n #ntern)tion)l /ooper)tors 8uide. www.cipot)to.org.

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F1 G /#. . :?. 19"". 2rom)gronomic d)t) to 2)rmer recommend)tions: *n economics tr)ining m)nu)l. +etrie3ed 2rom bitstre)m/h)ndle/10""3/"30/ 13"03.

F1EG 6$1* (6nited $t)te 1ep)rtment o2 *griculture). 201&. %)tur)l resources conser3)tion ser3ice- eC)min)tion)nd description o2 soil pro2iles. (nline)t: https://www.nrcs.usd).go3/wps/port)l/nrcs/det)il/soils/re2/Scid Pnrcs1!2p2-0&!2&3. F*ccessed 13 *ugust 2019G.

F1"G ?e;)lign .)mo- ?e;)lign ?)dese)nd *du)5i 0. *. 1991. $oil- pl)nt- w)ter- 2ertili9er-)nim)l m)nure)nd compost)n)l5sis m)nu)l. 'l)nt $cience 1i3ision <or;ing 1ocument 13- #@/*- *ddis *b)b)- 0thiopi).

F19G >)geri)- %. Q- =)lig)r A. /-)nd Lones /. *. 2011. *Growth and Mineral Nutrition of Field Crops. 3rd Edition.* ?)5lor T >r)ncis 8roup- %: - pp &30.

F20G . urph5- 4. >. 19 ". * +eport on >ertilit5 $t)tus)nd (ther 1)t) on $ome $oils o2 0thiopi). 0Cperiment)l $t)tion =ulletin %o. !!. /ollege o2 *griculture 1ire 1)w)- 0thiopi). &&1 p.

F21G /ottenie- *. (19"0). $oil)nd pl)nt testing)s b)sis o2 2ertili9er recommend)tion. >*(soil bulletin 3"/2. >ood)nd *gricultur)l org)ni9)tion o2 the united n)tion- +ome.

F22G 0thio$#$ (0thiopi)n $oil #n2orm)tion $5stem). 201!. 0thiopi) $oil #n2orm)tion $5stem. 0thiopi)n *gricultur)l ?r)ns2orm)tion *genc5. *3)il)ble)t: http://www.)t).go3.et/projects/ethiopi)n-soil-in2orm)tion-s5stemethiosis/

F23G . uluneh $ir)j. 201". 022ects o2 =lended %'$= >ertili9er +)tes on 8rowth- : ield)nd : ield +el)ted ?r)its o2 'ot)to (*Solanum tuberosum* @.) A)rieties under #rrig)tion in 1egem 1istrict- /entr)l 4ighl)nd o2 0thiopi). . $c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5)- 0thiopi).

F2!G 8et)chew Q)hs)5. 201 . +esponse o2 'ot)to (*Solanum tuberosum* @.) A)rieties to %itrogen)nd =lended >ertili9ers under #rrig)tion)t .)ichew- $outhern ?igr)5- 0thiopi). *n . . $c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5)- 0thiopi).

F2&G 1est) =e;ele. 201". 03)lu)tion o2 blended)nd non-blended 2ertili9er t5pes)nd r)tes on pot)to (*Solanum tuberosum* @.) 5ield)nd 5ield components)t *ssos)- <estern 0thiopi). . $c. ?hesis- 4)w)s) 6ni3ersit5- 4)w)s).

F2 G ?)ntowijo5o- <.- A)n de >liert- 0. 200 . *ll)bout 'ot)toes) 4)ndboo; to the 0colog5)nd #ntegr)ted .)n)gement o2 'ot)to. #ntern)tion)l 'ot)to /entre. p.

F2EG 4)li3in- L. @- =e)ton- L. 1- ?isd)le $. @.)nd %elson- <. @. 2003. $oil 2ertilit5)nd 2ertili9ers. *n introduction to nutrient m)n)gement th ed. 'e)rson 0duc)tion- #nc.- ""-92pp.

F2"G 4)bt)m $etu. 2012. +esponse o2 'ot)to (*Solanum tuberosum* @.) to the)pplic)tion o2 'hosphorus)nd 'ot)ssium 2ertili9ers)t *ssos)- =enish)ngul 8umu9 +egion)l $t)te- <estern 0thiopi). .$c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5)- 0thiopi).

F29G .inw5elet Lemberie. 201E. 022ects o2 %'$ 2ertili9er r)te)nd #rrig)tion 2reBuenc5 determin)tion method on the growth)nd tuber 5ield o2 'ot)to (*Solanum tuberosum @.)* in Qog) #rrig)tion $cheme- <est 8ojj)m-)nd %orth-<estern 0thiopi). *n ..$c ?hesis 'resented to $chool o2 8r)du)te $tud5 o2 =)hir 1)r 6ni3ersit5- 0thiopi) =)hir 1)r 6ni3ersit5- (!): 20-3!.

F30G 4)ilu .ulet)- %ugusie 1ech)ss))nd L)m)l *bdul)hi. 2019. +esponse o2 #mpro3ed)nd @oc)l 'ot)to (*Solanum tuberosum* @.). /ulti3)rs to %itrogen >ertili9er. *International Journal of Food & Nutrition,* 2 (1): 1-1E.

F31G %ebi5) Libril. 201 . 022ect o2 depth)nd r)te o2 phosphorus 2ertili9er)pplic)tion on 5ield)nd 5ield rel)ted tr)its o2 pot)to)t 4)r)m)5)- e)stern 0thiopi). .$c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5).

F32G >ern)ndes- *. ..- $or)tto- +. '.-)nd 8ons)les- L. +. 201!. +oot morpholog5)nd phosphorus upt);e b5 pot)to culti3)rs grown under de2icient)nd su22icient phosphorus suppl5. *Horticulture Science.* 1"0: 190-19". doi: 10.101 /j.scient).10.03&.

F33G 8irm) /h)l)-)nd %iguisse 1ech)ss). 201&. 'er2orm)nce o2 pot)to (*Solanum tuberosum* @.) culti3)rs)nd sp)cing)t di22erent in centr)l highl)nds o2 0thiopi). *Ethiopian Journal Applied Science Technology,* (1): 23-!E.

F3!G *sse2) %uru. 200&. +esponse o2 two impro3ed pot)to 3)rieties to nitrogen)nd phosphorus)pplic)tion. .$c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5)- 0thiopi).

F3&G >i;re 1essie. 2012. #n2luence o2 %itrogen $uppl5 on :ield)nd :ield /omponents o2 'ot)to /ulti3)rs (*Solanum tuberosum* @.))nd %itrogen use 022icienc5 o2 the /ulti3)rs)t 1eb)r; 1istrict- %orth <estern 0thiopi) .$c ?hesis- 4)r)m)5) 6ni3ersit5- 4)r)m)5)- 0thiopi).

F3 G Q)renl)mpi- $. (.)nd <hite- '. L. 2009. 'ot)to proteins- lipids-)nd miner)ls. pp. 99-12&. #n: $ingh- L)nd Q)ur- @. (ed.). *Advances in Potato Biochemistry*. *Elsevier Academic Publishers*. .)r5l)nd- 6$*.

F3EG ?es2)5e *bebe- <ongch)och)nt- $.-)nd ?)5ch)sinpit);- ?. 2013. 03)lu)tion o2 speci2ic gr)3it5 o2 pot)to 3)rieties in 0thiopi))s) criterion 2or determining processing Bu)lit5. *Kasetsart Journal of Natural Science*- !E- 30-!1.

F3"G *min *b)bi5). 201". #ntegr)ted 6se o2 %'$ =lended >ertili9er)nd /)ttle .)nure 2or 8rowth- :ield)nd ,u)lit5 o2 'ot)to (*Solanum tuberosum* @.) under 1)bo 8hibe- Qebele- $e;) <ored) o2 Limm) Jone- $outhwest 0thiopi). .$c ?hesis- Limm) 6ni3ersit5- Limm)- 0thiopi).

F39G 0leiw)- 0. .- #br)him- $. *.)nd .oh)med- >. .. 2012. ?he combined e22ect o2 %'Q le3els)nd 2oli)r nutrition)l compounds on growth)nd 5ield p)r)meters o2 pot)to pl)nts (*Solanum tuberosum* @.). *African Journal of Microbiology Research*- (2!): &100-&109. 1(#: 10.&"9E/*L.+12.0"&.

F!0G Qir;m)n- ..*. 200E. 8lob)l m)r;ets 2or processed pot)to products. pp. 2E-!!. *In*: Areugdenhil- 1. (ed.). 'ot)to =iolog5)nd =iotechnolog5 *d3)nces)nd 'erspecti3es. 0lse3ier- (C2ord- 6Q.