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CONTENTS

Seed and oil yield of bidi tobacco (*Nicotiana tabacum* L.) varieties as influenced by planting geometry and fertilizer levels under rainfed vertisols

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ABSTRACT: A field experiment was undertaken at Regional Agriculture Research Station, Nandyal, Andhra Pradesh during 2018-20 on rainfed vertisols to study the effect of different planting geometry, fertilizer levels on seed and oil yield in different bidi tobacco (*Nicotiana tabacum* L.) varieties. The treatments consisted of two planting geometry (75 cm x 75 cm and 60 cm x 60 cm) as first factor, two fertilizer levels (100 % RDF - 110 N+70 P_2O_5+50 K_2O kg $ha^{-1}$and 150 % RDF-165 N+105 P_2O_5+75 K_2O kg ha^{-1}) as second factor and three bidi tobacco varieties (A119, Nandyal Pogaku-1 and ABD 132) as third factor tested in a factorial randomized block design with three replications. Two years pooled data revealed that significantly higher seed yield (444 kg ha^{-1}), oil yield (143.3 kg ha^{-1}), cured leaf yield (2023 kg ha^{-1}), lower leaf length (34.0 cm), leaf width (13.6 cm) and capsules per plant (547) were observed with plant geometry of 60 cm x 60 cm. Higher seed yield (446 kg ha^{-1}), oil yield (141.9 kg ha^{-1}), leaf length (37.1 cm), leaf width (15.4 cm) and cured leaf yield (2078 kg ha^{-1}), capsules per plant (647) were recorded with application of 150% Recommended Dose of Fertilisers (RDF) (165 N+105 P_2O_5+75 K_2O kg ha^{-1}) than 100% RDF. Significantly higher seed yield (459 kg ha^{-1}) and oil yield (148.1 kg ha^{-1}) were recorded with A119 than Nandyal Pogaku 1 and ABD 132. ABD 132 recorded higher plant height (146.3 cm), leaf length (37.5 cm), leaf width (15.9 cm) and cured leaf yield (2116 kg ha^{-1}). Higher number of capsules per plant (675) was observed in Nandyal pogaku 1. A119 recorded higher seed yield (532 kg ha^{-1}) and oil yield (173.4 kgha^{-1}) when planted at 60 cm x 60 cm with application of 150% RDF (165 N+105 P_2O_5+75 K_2O ha^{-1}). ABD 132 recorded lower seed yield (229 kg ha^{-1}) and oil yield (72.1 kg ha^{-1}) when planted at 75 cm x 75 cm with application of 100% RDF (110 N+70 P_2O_5+50 K_2O ha^{-1}). The levels of plant geometry and fertilizer levels had non-significant effect on leaf chemical constituents.

Key words*:* Cured leaf yield, fertilizer levels, oil yield, plant geometry, seed yield

Alternative uses of bidi tobacco (*Nicotiana tabacum* L.) gained importance in recent times to sustain the crop for non-conventional and economically viable application in food and industries. The research on alternative uses of tobacco is the order of the day, leading to critical examination of potentials of tobacco as 'an oil seed crop'. Furthermore, the tobacco seed cake, which is an oil extraction by-product, turns out to be a suitable source of amino acids for animal feed formulations (Ouyang *et al.,* 2003). An estimated 1300- 1500 tonnes of tobacco seed oil is expelled and exported from India to other countries for utilization in paint industry (Singh and Rao, 2005). Tobacco varieties can guarantee a good oil yield from 30 to 40 % of seed dry weight, which has been successfully tested as a biodiesel (Usta, 2005). It is used as raw material in coating industries, preparation of printing inks, dyes, production of soaps, shoe polish, varnishes, an alternative to diesel fuel and potential use in food and coating industries (Mukhtar *et al.,* 2007). Tobacco seed oil has wide variation in its fatty acid composition depending on the varieties, climatic condition under which plants are grown (Zlatanov *et al.,* 2007; Abbas *et al.,* 2008). Tobacco seed oil has great promise as edible oil due to dietary effect of linoleic acid in lowering the serum cholesterol. Tobacco is an industrial crop traditionally used for cigarette and cigar manufacturing. However, applying cold pressing, 93 % of the seed oil can be recovered (Stanisavljevic *et al.*, 2009).

The promising alternative uses of tobacco are seed oil having nutritive, pharmaceutical and industrial uses (Awolola *et al.,* 2010). The tobacco seed contains on an average of 35% oil and linoleic acid is the major fatty acid (66 – 76%) (Sivaraju *et al.,* 2011). In spite of being a promising non-food crop for bioenergy, the industrial use of tobacco oil has been hampered by the low seed productivity. Tobacco plants have also been genetically engineered to enhance their oil content in green tissues for potential biofuel production (Vanhercke *et al.,* 2014). Tobacco can really become a novel industrial crop providing renewable sources for both biofuel and biomass as well with a further optimization of the cultivation protocol to increase the oil yield and to use the by-products (Michelle *et al.,* 2016). However, the tobacco seed oil is not being used for edible purpose in India. The demand for edible oils in India has experienced a growth rate of

4.43% from 2001 to 2011. There has been a significant gap between demand and supply of edible oil because of limited oil seeds and shifting of acreage to other crops, thus making need to search for alternative sources of edible oils. To promote tobacco as an oil seed crop, detailed research and identification of tobacco genotypes with high seed and oil yield potential. In the existing domestic demand - supply gap for edible oils, besides other approaches, tapping the potential of non-conventional sources of vegetable oil assumes greater relevance. Tobacco can fit as an additional oil seed crop, if its cultivation solely for seed oil extraction proves economically viable. It depends primarily on realizing high seed yields, the oil content and quality being satisfactory. The present study therefore was taken up to identify tobacco varieties for higher seed and oil yield potential.

MATERIALS AND METHODS

A field experiment was undertaken at Regional Agriculture Research Station, Nandyal, Andhra Pradesh for two consecutive years *viz.,* 2018-19 and 2019-20 on rainfed vertisols to study the effect of different planting geometry, fertilizer levels on seed and oil yield in different bidi tobacco varieties. The treatments consisted of two plant geometry (75 cm x 75 cm and 60 cm x 60 cm) as first factor, two fertilizer levels (100 % RDF - 110 N+70 P_20_5+50 K_2O $ha^{-1}$and 150 % RDF-165 N+105 P_20_5+75 K_2O ha^{-1}) as second factor and three bidi tobacco varieties (A119, Nandyal Pogaku-1 and ABD 132) as third factor in factorial randomized block design with three replications. The soil of experimental site was medium deep black, moderately alkaline (*p*H-8.2), non saline (EC-0.11 ds m^{-1}), low in nitrogen (152.3 kg ha^{-1}), medium in available P_2O_5 (32.5 kg ha^{-1}) and high in available K_2O (350.9 kg ha^{-1}). The fertilizers were applied through ammonium sulphate for nitrogen, single superphosphate for phosphorus and sulphate of potash for potassium. Half of the nitrogen, total phosphorus and potassium were applied as basal and remaining half nitrogen was applied as top dressing within 30-40 days after planting. An amount of 217.2 mm rainfall was received in 20 rainy days with 65.8 % deficit compared to normal during 2018 whereas 856.0 mm rainfall was received in 39 rain days with 45.1% excess rainfall during 2019. Crop management practices like land preparation, planting, weed control, intercultivation, need based plant protection, de-suckering and sun curing were followed as per recommended practice. The data were recorded for plant height, leaf length, leaf width, cured leaf yield, seed yield and oil yield. The leaf samples were used for estimating chemical quality constituents *viz*., nicotine, reducing sugars (Harvey *et al*., 1969) and chlorides (Hanumantha *et al.,* 1980). Three factor analysis of variance (ANOVA) was carried out for the analysis of growth, yield and leaf chemical constituents gathered data (Panse and Sukhatme, 1985). Critical difference (CD) values were computed at 0.05 level to find out whether statistically significant differences existed within plant geometry, fertilizer and varieties. Interactions between the factors were also studied.

RESULTS AND DISCUSSION

Effect of planting geometry

Plant at 60 cm x 60 cm recorded taller plant (139.1 cm), shorter leaf (34.0 cm), leaf width (13.6 cm), higher cured leaf yield (2023 kg ha^{-1}), lower capsules (547 $plant^{-1}$), higher seed yield (444 kg ha^{-1}) and oil yield (143.3 kg ha^{-1}) when compared to plant at 75 cm x 75 cm (133.0 cm; 37.1 cm; 15.6 cm; 1765 kg ha^{-1}; 678 $plant^{-1}$; 365 kg ha^{-1}; 115.7 kg ha^{-1} , respectively) (Table 1). The number of capsules was more as the crop received sufficient sunlight and nutrients at wider spacing (Kumaresan *et al.,* 2011). The increase in plant population in the closer spacing resulted in increased seed yield due to higher capsules. The wider spacing, 75 x 75 cm recorded a lower seed yield which could be attributed to the lower plant population. The increase in seed yield resulted in increased oil yield. Rangaiah and Nagesh (2009) found that the oil yield of tobacco was significantly associated with seed yield of tobacco. There was no significant effect of plant geometry on leaf chemical constituents. In general bidi tobacco leaf has nicotine of 4.2 – 5.7 %, reducing sugars of 2.7 – 3.9% and chlorides of 1.2 – 2.0 %. However, in present study, leaf chemical constituent analysis indicated poor quality of leaf i.e., lower nicotine (2.27 - 2.34%) and higher chlorides (2.55 - 2.58 %) probably due diversion of nutrients to capsules because of non topping for seed purpose.

Effect of fertilizer levels

Application of 150 % RDF (165 N+105 P_2O_5+75 K_2O) recorded taller plant (140.2 cm), higher leaf length (37.1 cm), leaf width (15.4 cm), higher cured leaf yield (2078 kg ha^{-1}), number of capsules (647 $plant^{-1}$), seed yield (446 kg ha^{-1}) and oil yield (141.9 kg ha^{-1}) when compared to application of 100 % RDF (110 N+70 P_2O_5+50 K_2O) (131.8 cm; 33.9 cm; 13.9 cm; 1711 kg ha^{-1}; 575 $plant^{-1}$; 364 kg ha^{-1}; 117.0 kg ha^{-1} , respectively). The plant height and yield attributes were more as the crop received sufficient quantity of N. There was no significant effect of fertilizer levels on leaf chemical constituents. However, leaf chemical constituent analysis indicated poor quality of leaf i.e., lower nicotine (2.16 - 2.44%) and higher

Table 1: Effect of different planting geometry and fertilizer levels on growth, cured leaf yield, seed yield, oil yield and leaf chemical constituents of bidi tobacco varieties (pooled data)

Treatments	Plant height (cm)	Leaf length (cm)	Leaf width (cm)	Curedleaf yield (kg ha^{-1})	No of capsules/ Plant	Seed yield (kg/ha)	Oil content (%)	Oil yield (kg ha^{-1})	Nicotine (%)	Reducing sugars	Chlorides (%)
Planting geometry											
75 cm x 75 cm	133.0	37.1	15.6	1765	678	365	31.70	115.7	2.34	2.69	2.55
60 cm x 60 cm	139.1	34.0	13.6	2023	547	444	32.26	143.3	2.27	2.84	2.58
S.Em±	3.9	0.6	0.4	51.0	18	12.0		3.8	0.13	0.17	0.20
CD (P=0.05)	NS	1.9	1.4	149	54	35		11.2	NS	NS	NS
Fertilizer levels											
100 % RDF	131.8	33.9	13.9	1711	575	364	32.15	117.0	2.44	2.77	2.69
150 % RDF	140.2	37.1	15.4	2078	647	446	31.81	141.9	2.16	2.76	2.44
S.Em±	3.9	0.6	0.4	51.0	18	12.0		3.8	0.13	0.17	0.20
CD (P=0.05)	NS	1.9	1.4	149	54	35		11.2	NS	NS	NS
Varieties											
A119	128.5	33.4	13.2	1676	539	459	32.19	148.1	1.97	2.61	2.49
Nandyal Pogaku 1	133.2	35.7	14.9	1892	675	414	31.91	132.1	2.10	3.00	2.29
ABD 132	146.3	37.5	15.9	2116	620	341	31.84	108.2	2.85	2.71	2.91
S.Em±	4.8	0.8	0.6	62.7	23	14.5		4.6	0.17	0.22	0.26
CD (P=0.05)	14.7	2.4	1.7	184	67	43		13.7	0.50	NS	NS
Interactions	NS	NS	NS	NS	NS	NS		NS	NS	NS	NS
CV (%)	10.9	10.6	8.7	15.5	13.8	13.2		12.8	9.7	8.9	9.2

Note: 100 % RDF - 110 N+70 P_2O_5+50 K_2O kg ha^{-1}; 150 % RDF - 165 N+105 P_2O_5+75 K_2O kg ha^{-1}

Table 2: Interaction effect of different planting geometry and fertilizer levels on seed yield and oil yield of bidi tobacco varieties

		Seed yield (kg ha^{-1})					Oil yield (kg ha^{-1})				
Planting geometry		75 cm x 75 cm		60 cm x 60 cm			75 cm x 75 cm		60 cm x 60 cm		
Fertilizer		100 % RDF	150% RDF	100% RDF	150% RDF	Mean RDF	100% RDF	150% RDF	100% RDF	150%	Mean
Varieties	A119	352	426	526	532	459	111.1	134.8	173.2	173.4	148.1
	Nandyal Pogaku 1	364	419	413	460	414	114.9	134.5	132.8	146.1	132.1
	ABD 132	229	399	297	439	341	72.1	126.8	98.1	135.9	108.2
	Mean	365		444			115.7		143.3		
	100 % RDF		364					117.0			
	150 % RDF		446					141.9			
		S.Em±		CD (P=0.05)			S.Em±		CD (P=0.05)		
Planting geometry (P)		12.0		35			3.8		11.2		
Fertilizer levels (F)		12.0		35			3.8		11.2		
P x F		16.7		NS			5.3		NS		
Varieties (V)		14.5		43			4.6		13.7		
P X V		20.6		NS			6.5		NS		
F X V		20.6		NS			6.5		NS		
P X F X V		29.2		NS			9.2		NS		

Note: 100 % RDF - 110 N+70 P_2O_5+50 K_2O kg ha^{-1}; 150 % RDF - 165 N+105 P_2O_5+75 K_2O kg ha^{-1}

chlorides (2.44 - 2.69 %) probably due diversion of nutrients to capsules because of non topping for seed purpose.

Effect of varieties

ABD 132 produced taller plant (146.3 cm), higher leaf length (37.5 cm), leaf width (15.9 cm) and higher cured leaf yield (2116 kg ha^{-1}). Nandyal pogaku 1 recorded higher capsules (675 plant^{-1}). A119 recorded higher seed yield (459 kg ha^{-1}) and oil yield (148.1 kg ha^{-1}). The varieties, in addition to seed, produced 1676 to 2116 kg ha^{-1} of lower grade cured leaf. Seed oil content has been reported to show high heritability and moderate genetic advance (Lalithadevi *et al.,* 2002) and highly significant correlation with seed weight, emphasizing the possibility of combining both high seed yield and high oil content. The per cent of oil observed in the present studies was higher than the average of 29.82% reported in three varieties of tobacco grown in Bangladesh (Abbas *et al.,* 2008). The results showed considerable variability among the varieties which may be attributed to genetic variability and helpful for selection of varieties. Sivaraju *et al.* (2015) reported similar results. ABD 132 recorded higher nicotine (2.85%). There was no significant effect of varieties on reducing sugars and chlorides.

Interaction

A119 recorded higher seed yield (532 kg ha^{-1}) and oil yield (173.4 kg ha^{-1}) when planted at 60 cm x 60 cm with application of 150 % RDF (165 N+105 $P_2 0_5$+75 K_2O) whereas ABD 132 recorded lower seed yield (229 kg ha^{-1}) and oil yield (72.1 kg ha^{-1}) when planted at 75 cm x 75 cm with application of 100 % RDF (110 N+70 $P_2 0_5$+50 K_2O) (Table 2).

CONCLUSION

A119 recorded higher seed yield (532 kg ha^{-1}) and oil yield (173.4 kg ha^{-1}) when planted at 60 cm x 60 cm with application of 150 % RDF (165 N+105 $P_2 0_5$+75 K_2O).

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