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FODDER PRODUCTIVITY AND QUALITY OF NAPIER BAJRA HYBRID (*PENNISETUM PURPUREUM* × *PENNISETUM GLAUCUM*) AND SUMMER FODDER INTERCROPS WITH DIFFERENT SEED RATES

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SUMMARY

The field experiment was conducted to standardize the seed rate of intercrops (cowpea, maize and Bajra) in Napier Bajra hybrid at Forage Research Farm, Departmentof Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana during **kharif** 2016. The experiment constituted of sixteen treatments Napier Bajra hybrid + Cowpea (25, 50, 75 and 100% of recommended seed rate), Napier Bajra hybrid + Bajra (25, 50, 75 and 100% of recommended seed rate), Napier Bajra hybrid + Maize (25, 50, 75 and 100% of recommended seed rate) and the sole crops of Napier Bajra hybrid, cowpea, maize and Bajra replicated thrice in randomized complete block design. Maximum plant height and tillers/ stump were recorded in sole Napier Bajra hybrid. Plant height in sole Napier Bajra hybrid was at par with intercropping of Napier Bajra hybrid with cowpea (25, 50 and 75% of recommended seed rate), maize (25 and 50% of recommended seed rate) and Bajra (25% of recommended seed rate). Whereas, the leaf stem ratio was maximum with 100% recommended seed rate of intercrops. Weed density was lowest in Napier Bajra hybrid + cowpea 100% while maximum weed density was noticed in sole Napier Bajra hybrid. Total green fodder productivity was maximum in Napier Bajra hybrid + cowpea 100% which was at par with cowpea (50 and 75% of recommended seed rate) and maize (25% of recommended seed rate). The higher crude protein and lower oxalate content was observed in intercropping of Napier Bajra hybrid and cowpea at all the seed rates. Higher value of competitive ratio and positive sign of the aggressivity for Napier Bajra indicated its dominant behaviour in intercropping system except with maize and Bajra at 100% of recommended seed rate. Benefit cost ratio was higher in all combinations of Napier Bajra hybrid + cowpea and Napier Bajra + maize/Bajra (25 and 50% of recommended seed rate).

Key words : Napier Bajra hybrid, intercrops, seed rate, quality, competitive ratio

India inhabits about 15% of world's livestock population on 2% geographic area, which itself is an indicative of the extent of livestock pressure on our resources in comparison to other countries and contributes about 21% of agricultural income of the family (Sharma *et al*., 2009). At present, condition of the majority of animals is deplorably poor due to underfeeding and malnutrition, which is usually ascribed to fluctuating and inconsistent supply of quality fodder. Availability of nutritious fodder is inadequate in the India, faces a net deficit of 61.1% green fodder, 21.9% dry crop residues and 64% feeds (Kumar *et al.,* 2012). Two approaches to bridge gap between fodder requirement and availability are either to increase in area under fodder production or increase the productivity per unit area per unit time under the present scenario of production system. Since the scope of area expansion under cultivated fodder (5% of cultivable area) is limited. Therefore, second approach to increase productivity with intercropping becomes a necessity in the present scenario.

Napier Bajra hybrid is gaining importance in livestock production because of its quick re-growth, profuse tillering habit, high herbage yield, palatable, nutritious fodder, resistant to insect-pest and diseases and adaptability to varying soil and climatic conditions (Faruqui *et al.,* 2009). It contains 8.7% crude protein, 32.8% crude fibre, 10.9% ash with calcium and phosphorus content. Fodder yield of first cut of Napier Bajra hybrid is very less due to the slow vegetative growth and few tillers initially. The fodder yield of first cut and quality parameters of Napier Bajra hybrid can be increased with intercrops of short duration and quick growing crops such as cowpea, maize and Bajra. Intercropping is the alternative method to reduce the gap between the availability and requirement of the fodder crops. It increases the fodder production per unit area per unit time. Green herbage in addition to

energy also provides vitamins, minerals with better dry matter digestibility (Surve *et al.*, 2012). The annual fodder crops such as cowpea is high in crude protein content and digestibility, while maize and Bajra give higher green fodder yield in lean period. Cereal quick growing crops such as pearlmillet and maize intercropped in Napier Bajra hybrid may be helpful in increasing the green fodder yield of first cut of Napier Bajra hybrid. Therefore, cowpea, maize and bajra can be intercropped with Napier Bajra hybrid to get high green fodder yield and quality forages.The present experiment was conducted to standardize the seed rate of intercrops with Napier Bajra hybrid.

MATERIALS AND METHODS

A field experiment was conducted at Forage Research Farm, Departmentof Plant Breeding and Genetics, Punjab Agricultural University Ludhiana, Punjab (30°54′N, 75°48′E, 247 m MSL) during **kharif** 2016. During the growth period of crop maximum 39.6ºC and minimum 12ºC air temperature were recorded in May and November, respectively. The mean monthly relative humidity ranged from 41.8 to 75.1%. The total amount of rainfall received during crop period (March to November) was 563.4 mm. Soil of experimental field was loamy sand with low organic carbon (0.26%) and available nitrogen (218.4 kg/ha). However, medium range of available phosphorus (19.2 kg/ha) and potassium (180.5 kg/ha). Soil pH (7.53) and electrical conductivity (0.38 ds/m) were in the normal range.The experiment was conducted in randomized complete block design with three replications with 16 treatments viz. Napier Bajra hybrid +Cowpea (25% of recommended seed rate-RSR), Napier Bajra hybrid+Cowpea (50% RSR), Napier Bajra hybrid+Cowpea (75% RSR), Napier Bajra hybrid+Cowpea (100% RSR), Napier Bajra hybrid+Bajra (25% RSR), Napier Bajra hybrid+Bajra (50% RSR), Napier Bajra hybrid+Bajra (75% RSR), Napier Bajra hybrid+Bajra (100% RSR), Napier Bajra hybrid+Maize (25% RSR), Napier Bajra hybrid+ Maize (50% RSR), Napier Bajra hybrid+Maize (75% RSR), Napier Bajra hybrid+Maize (100% RSR), Napier Bajra hybrid sole, cowpea sole, maize sole and Bajra sole.Napier Bajra hybrid variety PBN 346 was planted using 27500 root slips/ha at a spacing of 60 × 60 cm on 22nd March 2016. Intercrops (cowpea, maize and Bajra) were sown in between Napier Bajra hybrid with row ratio of 1:1. Recommended seed rates for cowpea, Bajra and maize was 62.5, 20 and 75 kg/ha, respectively.

Farm yard manure was applied @ 20 t/ha before planting the crop. Recommended dose of nitrogen (75 kg/ha) was applied at 15 days after planting and after each cut. A total of five cuts Napier Bajra hybrid were taken. Intercrops gave green fodder yield during the first cut only. The first cut was taken at 60 days after planting (DAP) of the experiment and subsequent cuts ofNapier Bajra hybrid were taken at an interval of 30 days. At the time of harvest fresh green fodder weight was recorded immediately and plant samples were oven dried for working out dry fodder yield. Weed density was recorded at 30 and 50 DAP from one square metre area using quadrant of 1 × 1 m^2. The dry matter of weeds was taken and converted to per square metre.

LER indicates the total land area required by the sole crops to achieve the same yield as the intercrops (Willey, 1985). When LER is greater than 1, intercropping favors the growth and yield of the crops. LER was calculated as following:

$$LER = LER_a + LER_b$$
$$LER_a = Y_{ab}/Y_a$$
$$LER_b = Y_{ba}/Y_b$$

LER_a and LER_b are the partial LER of crops ‘a’ and ‘b, respectively. Y_{ab} is yield of crop a when grown with crop b and Y_{ba}yield of crop b when grown with crop b; Y_{aa} and Y_{bb} are the yields per unit area when a and b grown as sole crops under those conditions with which comparison are to be made.Competitive ratio denotes simply the ratio of LERs of the two component crops individually and takes into account the proportion of the crops in which they are initially sown (Willey and Rao, 1980). The CR is calculated according to the following formula:

$$CRa = \frac{Y_{ab}}{Y_{aa} \times Z_{ab}} \div \frac{Y_{ba}}{Y_{bb} \times Z_{ba}}$$

$$CR_a = (LER_a/LER_b)\ (Z_{ba}/Z_{ab})$$
$$CR_b = (LER_b/LER_a)\ (Z_{ab}/Z_{ba})$$

Z_{ab} and Z_{ba} are the proportion of intercropped area initially allocated to crop ‘a’ and ‘b’, respectively.Aggressivity is index that is often used to specify how much the relative yield increase in crop ‘a’ is greater than that for crop ‘b’ and vice versa in an intercropping system. Aggressivity shows the degree of dominance of one crop over other the crop when sown together (McGilchrist, 1965).

$$A_a = (Y_{ab} / Y_a \times Z_{ab}) - (Y_{ba} / Y_b \times Z_{ba})$$
$$A_b = (Y_{ba} / Y_b \times Z_{ba}) - (Y_{ab} / Y_a \times Z_{ba})$$

Where, A_{ab} and A_{ba} are the Aggressivity of crop 'a' and 'b' intercropped with crop 'b' and 'a', respectively. An Agressivity value of zero indicates that component crops are equally competitive. When both the components crops in any situation will have the same numerical value but the sign for the dominant crop will be positive and for dominated crop will be negative. Greater the numerical value, larger the difference in competitive abilities.

RESULTS AND DISCUSSION

Growth attributes and green fodder yield

Number of tillers per stump of Napier Bajra hybrid in different intercropping systems were statistically at par with each other and significantly lower than sole Napier Bajra hybrid (Table 1). This might be due to more crowding with intercrops and increase in the competition which leads to decreased number of tillers per stump as compared to sole crop. Guleria and Kumar (2016) also reported reduction in tiller numbers in intercropping system. Plant height was maximum in sole planting of Napier Bajra hybrid which was statistically at par with Napier Bajra hybrid + cowpea 25%, Napier Bajra hybrid + cowpea 50%, Napier Bajra hybrid + cowpea 75% and Napier Bajra hybrid + maize 25% and Napier Bajra hybrid + maize 50%. The reduction in plant height of Napier Bajra hybrid with increasing seed rate of intercrops may be attributed to increase in plant population of intercrops which offered maximum interspecific competition with Napier Bajra hybrid. Babu *et al.*, 1994 also observed that higher seed rates of cowpea suppressed the growth of hybrid maize which was evident from reduction in plant height of maize. Maximum leaf stem ratio was found in Napier Bajra hybrid + cowpea 100% treatment which was on par with Napier Bajra hybrid+ cowpea 75%, Napier Bajra hybrid + Bajra 100% and Napier Bajra hybrid + maize 100%. This increase of leaf stem ratio might be due to the less plant height in respective treatments.

Green fodder yield at first cut was significantly higher in Napier Bajra hybrid + cowpea 25%intercrop over rest of the treatments. Increased seed proportion of cowpea and at all the proportions of bajra and maize had adverse effect on green fodder yield of Napier Bajra hybrid due to more competition. Cowpea being a leguminous crop had positive role for nitrogen fixation which contributed to increase of total green fodder yield as compared to cereal fodder crops (maize and bajra). Bajra and maize at higher seed proportion proved more nutrient exhaustive crops for decreasing the total green fodder yield. Higher green fodder yield of sole Napier Bajra hybrid might be due to limited disturbance of the habitat, optimum space utilization, adequate availability of moisture, nutrient and light (Ayenhbad and Behrooz, 2011). Total green fodder yield was highest (1704.0 q/ha) in Napier Bajra hybrid + cowpea 100% (Table 1) which was at par with cowpea (50 and 75% of seed rate) and maize (25% of seed rate). Nyamagonda *et al.*, (2002) also observed higher green fodder yield in maize + fieldbean intercropping with 100:50 population ratio.

TABLE 1
Effect of intercrops with different seed proportions on growth attributes of Napier Bajra hybrid, weed density, weed dry matter and green fodder yield.

Treatment	Tillers/ stump	Plant height (cm)	Leaf to stem ratio	Green fodder yield				Weed density		Weed dry matter	
				NBH	Intercrops (1st cut)	Total	Total of five cuts	30 DAP	50 DAP	30 DAP	50 DAP
NBH+cowpea 25%	18	96.8	1.07	293.0	50.9	343.9	1562.8	49.0	74.7	37.0	54.5
NBH+cowpea 50%	17	95.3	1.11	246.9	63.8	310.7	1642.7	36.0	50.7	22.4	31.7
NBH+cowpea 75%	17	91.3	1.15	216.7	84.2	300.9	1699.7	27.3	40.0	10.6	13.7
NBH+cowpea 100%	16	87.0	1.19	159.7	100.8	260.5	1704.0	14.7	22.7	6.3	7.8
NBH+bajra 25%	17	88.0	1.04	243.0	62.5	305.5	1574.5	55.3	84.0	53.5	76.2
NBH+bajra 50%	17	85.5	1.05	220.0	104.2	324.2	1551.0	48.0	65.3	40.9	63.3
NBH+bajra 75%	16	80.1	1.11	191.4	127.3	318.7	1458.4	32.0	51.0	26.8	44.5
NBH+bajra 100%	15	71.0	1.15	136.3	157.7	294.0	1414.5	28.0	40.3	13.1	26.9
NBH+maize 25%	17	90.9	1.08	248.3	60.8	309.1	1625.5	52.3	78.7	45.1	65.1
NBH+maize 50%	17	89.9	1.09	225.7	76.8	302.5	1570.0	43.3	59.7	31.3	49.9
NBH+maize 75%	17	86.2	1.12	192.8	103.9	296.7	1457.4	30.3	45.7	19.7	36.0
NBH+maize 100%	15	76.6	1.15	154.7	139.7	294.4	1500.9	22.3	34.3	10.0	22.2
NBH sole	24	99.5	1.12	295.2	-	295.2	1497.9	66.0	95.7	57.3	94.2
C. D. (P=0.05)	3.1	12.4	0.05	37.42	-	36.42	94.39	3.67	6.10	3.51	3.64

Weed density and dry weight

The weed density and dry matter was brought down significantly by intercropping Napier Bajra hybridand cowpea/maize/Bajra as compared to sole Napier Bajra hybrid. At 30 and 50 days after planting, the lowest weed density and biomass was observed inNapier Bajra hybrid + cowpea100%, whereas maximum weed density and biomasswas recorded in sole Napier Bajra hybrid (Table 1).The lesser weed density and weed biomass in intercroppingtreatments may be due to higher crop canopy cover in intercropping systems than sole Napier Bajra hybrid. Tewari *et al.*(1989) also reported that extensive canopy of intercropsnot allowed penetration of solar radiation upto the weeds and smothered them leading to lower weed dry weight.

Fodder quality

Crude protein content of fodder increased as seed proportion of cowpea was increased and it decreasedwhen seed proportionof nutrient exhaustive crops (maize and bajra)was increased in intercropping system (Table 2). The highest crude protein content (17.9%) was noticed in Napier Bajra hybrid + 100% cowpea intercrops. The crude protein content of fodder decreased with increase in seed rates of bajra and maize from 8.59 to 7.92% Napier Bajra hybrid + bajra intercrops and 9.34 to 8.71% in Napier Bajra hybrid + maize intercrops. The higher crude protein content inNapier Bajra hybrid + cowpea intercrops was might be due to more availability of soil nitrogen as more nitrogen fixation. Asangla and Gohan (2016) also recorded higher crude protein in maize + cowpea intercropping than sole maize.

Oxalate content in fodder decreased in Napier Bajra hybrid + cowpea intercrops and increased with increase in seed proportion of maize and bajra but was below the toxic limit (10%). The higher oxalate content in Napier Bajra hybrid+maize/bajra intercrops was might be due to more competitive stress to Napier Bajra hybrid at higher seed rate (Sidhu *et al.*, 2014).

Competition indices

LER of intercropping system was significantly higher in Napier Bajra hybrid + cowpea 25%, whichwas statistically at par with Napier Bajra hybrid + cowpea 50% and Napier Bajra hybrid + cowpea 75%.The data on LER of different intercropping systems indicated the land advantage except in Napier Bajra hybrid + Bajra 100% indicating the more exhaustive nature of bajra (Table 2). Mengping and Zhangjinsong (2004) also observed that intercropping system showed higher LER than the sole planting of crops.

Aggressivity showed that Napier Bajra hybrid was the dominant species with positive values in intercropping systems except Napier Bajra hybrid + 100% seed rates of all intercrops. Kumar (2008)also observed negative values of aggressivityof intercrops (lentil and *toria*) indicating wheat was dominant crop in the intercropping systems.

Competitive ratio (CR) is another way to work out the degree with which one crop competes with another component crop. Napier Bajra hybrid was the dominant species with higher values over the

TABLE 2

Quality parameters, net returns, B : C and competitiveindicesas influenced by Napier Bajra hybrid based intercropping systems.

Treatment	Crude protein (%)	Oxalate (%)	LER	Aggresivity		Competitive ratio		Net returns (Rs./ha)	B : C
				Aa	Ab	CRa	CRb		
NBH+cowpea 25%	16.6	2.49	1.25	0.05	-0.05	3.21	0.30	76786.5	1.81
NBH+cowpea 50%	17.1	2.40	1.16	0.03	-0.03	2.20	0.44	82123.6	1.88
NBH+cowpea 75%	17.5	2.36	1.16	0.02	-0.02	1.45	0.70	86038.3	1.92
NBH+cowpea 100%	17.9	2.24	1.03	-0.01	0.01	0.92	1.19	85856.8	1.87
NBH+bajra 25%	8.59	3.69	1.03	0.04	-0.04	3.59	0.32	77439.6	1.86
NBH+bajra 50%	8.24	3.72	1.03	0.02	-0.02	1.86	0.55	76005.3	1.81
NBH+bajra 75%	7.95	3.76	1.02	0.01	-0.01	1.31	0.77	69098.0	1.64
NBH+bajra 100%	7.92	3.80	0.98	-0.01	0.01	0.76	1.36	65970.1	1.55
NBH+maize 25%	9.34	2.73	1.06	0.04	-0.04	3.33	0.31	81690.4	1.94
NBH+maize 50%	9.19	2.60	1.05	0.03	-0.03	2.30	0.47	77264.5	1.81
NBH+maize 75%	8.86	2.52	1.05	0.01	-0.01	1.43	0.70	68855.7	1.58
NBH+maize 100%	8.71	2.48	1.01	-0.01	0.01	0.86	1.22	72470.6	1.64
NBH sole	8.68	3.72	-	-	-	-	-	71051.5	1.72
C. D. (P=0.05)	0.81	0.17	0.12	0.014	0.014	0.895	0.328	7078.5	0.17

intercrops in the intercropping systems except for Napier Bajra hybrid + 100% seed rates of all intercrops. Yilmaz *et al.* (2008) also reported higher value of competitive ratio for maize in maize + legume intercropping.

Economics

Napier Bajra hybrid intercropping with cowpea 75% of recommended seed rate recorded significantly higher net returns which was at par with cowpea (50, 75 and 100%) and maize 25%. The higher net returns was the result of greater total green fodder yield of the systems. In respect of benefit cost ratio, Napier Bajra hybrid+maize 25% recorded significantly higher B:C then sole Napier Bajra hybrid, but at par with intercropping of Napier Bajra hybrid with cowpea (25, 50, 75 and 100% of seed rates), Bajra (25 and 50% of seed rate) and maize (50% of seed rate). Pal *et al.* (2014) also reported higher net returns in sorghum + cowpea 50% intercropping system.

CONCLUSION

Intercropping of Napier Bajra hybrid with cowpea at 50% of recommended seed rate produced the higher total green fodder yield, land equivalent ratio, net returns and benefit cost ratio.Quality parameters- higher crude protein and lower oxalate content was also observed in intercropping of Napier Bajra hybrid with cowpea at 50% of seed rate.

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