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RELATIVE YIELD AND NUTRIENT STATUS OF SORGHUM-LEGUME FORAGE SYSTEM INFLUENCED BY DIFFERENT COMBINATIONS

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SUMMARY

The study was carried out during *kharif* season of 2018 at Faculty of Agriculture Wadura, SKUAST- Kashmir to evaluate the cropping system, nutrient content and uptake as influenced by different legume combination with sorghum. The experiment consisting of 10 treatments laid out in randomized completely block design with three replications. The soil of the experimental plot was sandy loam in texture, with low available nitrogen (175.2 kg/ha), medium in available phosphorus and potassium (11.2 kg/ha and 220.0 kg/ha) respectively, high in organic carbon (1.49%) and neutral pH (7.06). The result revealed that sorghum + soybean (2:1) intercropping system recorded the maximum relative yield total of 0.92 and relative crowding coefficient of 0.71 than rest of the cropping systems. Sole soybean recorded the highest nitrogen and potassium content (2.98%) which was at par with sole cowpea and sole sorghum recorded the highest phosphorus content (0.5%) while the maximum nitrogen uptake was observed in sorghum + soybean (2:1) and phosphorus and potassium uptake was observed highest in sole sorghum. Therefore, considering higher cropping system indices and N, P, K content and uptake, the sorghum + soybean (2:1) was superior than other legume combination with sorghum.

Key words: Forage, Nutrient content, Nutrient uptake, Relative crowding coefficient, Relative yield

Forages are considered to be the nourishing and low-cost feed for dairy animals (Iqbal *et al.*, 2015). In India, fodder crops are grown in only 4% area of the total cultivated area, which also leads to scarcity of green fodder, dry crop residues and concentrate feeds, i.e., 35.6 %, 10.95%. and 44 % respectively (IGFRI, Vision, 2050). Only 40% green forages are available from various sources to feed livestock which shows higher gap between supply and demand for fodder. In J&K and Ladakh, the livestock population is 8.32 million (20th livestock census) and only 4 % arable land in J&K, is under fodder crops, and there is a deficit of 67 per cent in green fodder and 27.31 per cent in dry fodder. The demand for both green and dry fodder is expected to increase considerably to 1012 million tones and 631 million tones, by 2050. Availability of green fodder with improved quality to animals is the key to success of dairy enterprise and it is demanding to continue the health and milk production of livestock without supply of the quality green fodder. With rapid increase in human population and less chance of bringing new land area under cultivation of fodder crops, intercropping appears to be one of the potential method to increase the amount of fodder produced and intensity of land use. Due to this, it is necessary to develop the right technique for cultivating quality fodder in association with legumes without excessive intercrop influence and competition. Cereals intercropping with legumes result in increased resource capture by component crops and improve soil microbial activity along with better efficiency of resource conversion which triggers higher biomass production (Alvey *et al.*, 2003). In addition, soil fertility is enhanced when cereal forages are intercropped with legumes (Iqbal *et al.*, 2018c). Intercropping of sorghum with legumes is known practice for increasing the productivity, quality, palatability, yield increment, high crude protein percentage, protein yield and profitability per unit area and time. Among the *kharif* forage crops, sorghum (*Sorghum bicolor* L.) is an important one that possesses a wide range of ecological adaptability because of its xerophytic characteristics. Its fodder is fed to almost every class of livestock and can be used as hay or silage. However, sorghum fodder is poor in quality due to low protein content and presence of hydrocyanic acid (Hingra *et al.*, 1995). It is therefore, imperative to improve the quality and quantity of sorghum fodder. Intercropping of forage sorghum with legumes (cowpea, soybean) can boost green forage yield per unit land area with greater forage agro-qualitative characteristics (Surve *et al.*, 2011).

MATERIALS AND METHODS

A field experiment was conducted during *kharif* 2018 at Agronomy Farm of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, FoA, Wadura, Sopore under rainfed conditions. The experimental site was located in the north western Himalaya's temperate zone characterized by hot summer and very cold winters with mean annual rainfall of 339.5 mm. The mean maximum temperature was 28.6 ^{0}C and mean minimum temperature was 14.4 ^{0}C. The soil of the experimental field was sandy loam, having pH 7.06, organic carbon 1.49%, available N, P, and K of 175.21, 11.02 and 220 kg ha^{-1} respectively. The experimental field was laid out in a RCBD (Randomized complete block design) with ten treatments of sorghum based cropping system with three replications having a net plot size of 5.1 m * 4.0 m. The experiment comprising of 10 treatments. These treatments were: sole sorghum, sole cowpea, sole soybean (each 30 cm apart), sorghum intercropped with cowpea in 1: 1 and 2:1 ratio, sorghum intercropped with soybean in 1: 1 and 2:1 ratio, sorghum (70%) mixed cropping with cowpea and soybean (30%) and sorghum (70%) mixed with cowpea (15%) and soybean (15%). The experimental field was deep tilled and then leveled before starting the experiment. The fodder sorghum (MP Chari), fodder cowpea (Shalimar Cowpea-1) and fodder soybean (Shalimar soybean-1) were sown. Replacement series was used for accommodating component crops in intercropping treatments. Fodder sorghum was harvested at 50% flowering and intercrops at pod formation stage. Relative yield total and relative crowding coefficient were estimated to calculate the relative dominance of one species over other in intercropping. Plant samples of fodder sorghum, cowpea and soybean collected at harvest were oven dried at 65-70 ^{0}C to a constant weight. The samples were ground and subsequently used for chemical analysis. Finally, grind samples were analysed for nitrogen, phosphorus and potassium content (%) by "Modified Kjeldahl's Method", "Vanado-Molybdo-Phosphoric Yellow Colour Method" and "Extraction with Normal Ammonium Acetate Method". Nitrogen, phosphorus and potassium uptake was determined by multiplying dry matter accumulation with respective percentages of nitrogen, phosphorus and potassium content and then expressed in kg/ha. All the data recorded for different parameters were analysed by F test of significance on the basis of hypothesis Cochran and Cox (1963) and the least significant differences test at 5% probability level.

Relative yield total (RYT):

Relative yields of the crops were calculated as ratio of yields in mixture to yield in monoculture. The value of unity is the critical value for RYT, when the RYT value is greater than one it means that the intercropped favoured the growth and when the value is lower than one then intercropped negatively affected the growth and yield of the plants grown in mixtures. (Mead and Willey, 1980: Caballero *et al.*, 1995).

$RYT = RY_{sorghum} + RY_{intercrop}$

$RY_{sorghum}$ = yield of sorghum in mixture/yield of sorghum in sole

$RY_{intercrop}$ = yield of intercrop in mixture/ yield of intercrop in sole

Relative Crowding Coefficient (RCC):

This index determines the rate of competition between two species, which has been intercropped. According to Willey (1979), in an intercropping system, each crop has its own RCC. The component crop with higher 'RCC' value is the dominant and that with lower 'RCC' value is dominated. To determine if there is a yield advantage in intercropping, the product of the coefficient of both component crops is obtained and that is usually designated as 'RCC'. Treatments with RCC<1 are interpreted as non-profitability of intercropping in comparison with sole cropping.

Relative crowding coefficient (K) was estimated to calculate the relative dominance of one species over the other in intercropping by the following formula (De Wit, 1960).

$K = (k_{sorghum} * k_{legume})$, where

$K_{sorghum} = Y_{sl} * Z_{ls} / ((Y_s – Y_{sl}) Z_{sl}$, and

$K_{legume} = Y_{ls} * Z_{sl} / (Y_l – Y_{ls}) Z_{ls}$

Y_{sl} = yield of sorghum in intercropping

Y_m = yield of sorghum in sole cropping

Z_{ls} = sown proportion of intercrop in intercropping

Z_{sl} = sown proportion of sorghum in intercropping

Y_l = yield of intercrop in sole cropping

Y_{ls} = yield of intercrop in intercropping

RESULTS AND DISCUSSION

Relative yield total (RYT)

Highest relative yield total of 0.92 was recorded in sorghum + soybean (2:1) followed by sorghum + cowpea (1:1) of 0.88 compared to rest of the treatments and the lowest RYT of 0.75 was recorded in sorghum + cowpea mixed cropping. This may be due to less reduction in fodder yield of intercropping system ranging from 8 to 25 % compared to sole cropping system with least reduction observed in sorghum + soybean (2:1) (Table: 1).

Relative crowding coefficient (RCC)

When compared to other treatments, sorghum + soybean (2:1) recorded the highest relative crowding coefficient of 0.71 followed by sorghum + cowpea (1:1) with 0.62, and least value of 0.11 were observed in sorghum + cowpea + soybean mixed cropping (Table. 1). This may be explained by the intercropping system's high production of sorghum and soybean.

Nutrient content (N, P and K)

The sole fodder legume recorded significantly higher nitrogen content of 2.10% than the remaining treatments followed by 1.83 % in sorghum + soybean (1:1) significantly higher than sole sorghum (1.39%), however was at par with the remaining treatments (Table.2). This might be due to the reason that the dry matter of legumes accumulate high nitrogen content as compared to cereals. These results are in close conformity with the findings of Ranjan (1983).

Sole sorghum recorded higher phosphorus content (0.5%) followed by sorghum + soybean (2:1) (0.44%), sorghum + cowpea (2:1) (0.42%), sorghum + soybean (1:1) (0.41) (Table 2). This might be due to the reason that the dry matter of cereals accumulated high phosphorus content. These results were in close conformity with the findings of Ranjan (1983).

Sole soybean recorded higher potassium content (2.98%) followed by sole cowpea (2.97%), sorghum (70%) + cowpea (15%) + sole soybean (15%) (2.65%), sorghum + soybean (1:1) (2.49%) (Table 2). This might be due to the reason that the drymatter of legumes accumulate high potassium content as compared to cereals. These results are in close conformity with the findings of Ranjan (1983).

Nutrient uptake (N, P and K)

Sorghum + soybean (2:1) recorded significantly higher nitrogen uptake (275.21 kg/ha) followed by sorghum + soybean mixed cropping (267.39 kg/ha) (Table 2). This might be due to higher biomass production (Table 1) and nitrogen content of sorghum + soybean (2:1). Sole sorghum recorded significantly higher phosphorus uptake (93.07 kg/ha) followed by sorghum + soybean (2:1) (71.65kg/ha) (Table 2). This might be due to higher biomass production (Table 1) and phosphorus content of sole sorghum. Sorghum (70%) + cowpea (15%) + soybean (15%) mixed cropping recorded higher potassium uptake (372.3 kg/ha) followed by sorghum + soybean

TABLE 1

Dry matter accumulation, Relative yield total and Relative crowding coefficient of Sorghum and legumes as influenced by cropping system

Treatments	Dry matter accumulation (q/ha)	Relative yield total	Relative crowding coefficient
Sole sorghum (30 cm)	186.15	-	-
Sole cowpea (30 cm)	59.48	-	-
Sole soybean (30 cm)	87.62	-	-
Sorghum + cowpea (1:1)	121.40	0.88	0.62
Sorghum + cowpea (2:1)	141.08	0.76	0.15
Sorghum + soybean (1:1)	123.89	0.81	0.43
Sorghum + soybean (2:1)	162.85	0.92	0.71
Sorghum (70%) + cowpea (30%) mixed cropping	136.45	0.75	0.14
Sorghum (70%) + soybean (30%) mixed cropping	149.38	0.80	0.27
Sorghum (70%) + cowpea (15%) + soybean (15%) mixed cropping	146.55	0.80	0.11
SEm (±)	3.651	-	-
C. D. (p=0.05)	11.34	-	-

TABLE 2

Nitrogen, phosphorus and potassium content and uptake of sorghum and legumes as influenced by cropping system at harvest

Treatments	N content (%)	N uptake (kg/ha)	P content (%)	P uptake (kg/ha)	K content (%)	K uptake (kg/ha)
Sole sorghum (30 cm)	1.39	258.74	0.5	93.07	2.03	372.3
Sole cowpea (30 cm)	2.10	124.90	0.28	16.65	2.97	176.65
Sole soybean (30 cm)	2.10	184.00	0.32	28.03	2.98	261.10
Sorghum + cowpea (1:1)	1.78	216.09	0.39	47.34	2.48	301.07
Sorghum + cowpea (2:1)	1.63	229.96	0.42	59.25	2.32	327.30
Sorghum + soybean (1:1)	1.83	226.71	0.41	50.79	2.49	308.48
Sorghum + soybean (2:1)	1.69	275.21	0.44	71.65	2.32	377.81
Sorghum (70%) + cowpea (30%) mixed cropping	1.66	226.50	0.29	39.57	2.38	324.75
Sorghum (70%) + soybean (30%) mixed cropping	1.79	267.39	0.39	58.25	2.45	365.98
Sorghum (70%) + cowpea (15%) + soybean (15%) mixed cropping	1.76	257.92	0.37	54.22	2.65	388.35
SEm±	0.04	7.15	0.01	1.49	0.09	10.25
C. D. (p=0.05)	0.20	23.56	0.04	4.76	0.24	28.76

(2:1) (377.81 kg/ha) might be due to higher biomass production and potassium content of sorghum + cowpea + soybean mixed cropping.

CONCLUSION

It is concluded from the study that intercropping sorghum with soybean (2:1) was superior in terms of relative yield compared to other combination. However, sorghum + soybean (2:1) also recorded higher nitrogen uptake, reflecting higher protein productivity. Therefore, for higher relative yield and protein productivity sorghum + soybean (2:1) cropping should be adopted.

REFERENCES

Alvey, S., C. M. Yang, D. Buerkert and D. E. Crowley, 2003 : Cereal/legume rotation effects on rhizosphere bacterial community structure in West African soils. Biology and Fertility of soils. pp. 73-82. *Global Veterinary,* **14**(1): 23-33.

Caballero, R. and E. L. Goicoechta, 1995 : Forage yield and quality of common vetch and oat sown at varying seeding ratios of common vetch. *Field Crop Research,* **41**: 135-140.

Cochran, G.C. and M.M. Cox, 1963 : Experimental Designs. *Asia Publishing House,* Bombay pp. 293-316.

De Wit, C.T., 1960 : On competition. Verslag van land bouwkundigeonderzoekingen. Wageningen, **66**: 1-81.

Hingra, S. H., B. Davis and M. J. A. Akhtar, 1995 : Fodder production. Food and Agriculture Organisation of the United Nations, pp: 8.

IGFRI Vision 2050. Indian Grassland and Fodder Research Institute, Jhansi (UP).

Iqbal, M. A., A. Iqbal, N. Akbar, H. Z. Khan and R. N. Abbas, 2015 : A study on feed stuffs role in enhancing the productivity of milch animals in Pakistan-Existing scenario and future prospect.

Iqbal, M. A., A. Iqbal, Z. Maqbool, Z. Ahmad, E. Ali, M. H. Siddiqui and S. Ali, 2018c : Revamping soil quality and correlation studies for yield and yield attributes in sorghum-legumes intercropping systems. *Bioscience journal*, **34**, 1165-1176.

Mead, R., and R. W. Willey, 1980 : The concept of a land equivalent ratio and advantages in yield for intercropping. *Experimental. Agriculture*, **16**: 217-228.

Ranjan, S. K., 1983 : Animal and feeding practices. 3rd revised edition, pp.93-104.

Surve, V. H., P. R. Patil, and M. K. Arvadia, 2011 : Performance of fodder sorghum (*Sorghum bicolor* L.), maize (*Zea mays* L.) and cowpea [*Vigna unguiculata* (L.) Walp] under sole and intercropping systems. *Madras Agricultural Journal,* **98**(10-12): 372-374.

Willey, R.W., 1979 : Intercropping its importance and research needs part 2nd Agronomic relationship. *Field Crops Abstracts*., **32**: 73-85.