__Original Research Article__

EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM LEVELS ON YIELD AND ECONOMICS OF INTERSPECIFIC HYBRID COTTON (*Gossypium spp*) UNDER SOUTHERN DRY ZONE OF KARNATAKA

ABSTRACT

The field experiment was conducted at ZARS, V. C. Farm, Mandya during *Kharif* season of 2016 and 2017 in Southern Dry Zone of Karnataka to optimize levels of major nutrients for interspecific hybrid cotton. The experiment on nutrient management was laid out in RCBD with three replications using factorial concept involving nitrogen, phosphorus and potassium levels. The results revealed that application of 150 kg N ha^{-1} recorded significantly higher seed cotton yield (1857 kg ha^{-1}) and net returns (Rs. 46,198 ha^{-1}) compared to application of 100 kg N ha^{-1}. Among the phosphorus levels, significantly higher seed cotton yield (2046 kg ha^{-1}) and net returns (Rs. 54,383) were recorded with application of 75 kg P_2O_5 ha^{-1} over application of 50 kg P_2O_5 ha^{-1}. Among potassium levels, application of 100 kg K_2O ha^{-1} recorded significantly higher seed cotton yield (1942 kg ha^{-1}) and net returns (Rs. 49,608 ha^{-1}) as compared to application of 50 kg K_2O ha^{-1}.

Key words: Hybrid cotton, Seed cotton yield and Economics

INTRODUCTION

Cotton is popularly called as “White Gold” and considered as “King of fibre crops”. It is an important cash crop of global significance, which plays a dominant role in the world agriculture and industrial economy. India is the important grower of cotton on a global scale. It is one of the important cash crops for farming community. It is cultivated in India for fibre and oil purpose. Cotton is an important raw material for the Indian textile industry and contributes at least 65 per cent of its requirements. Textile industry in India significantly contributes for Indian economy with over 4 million handlooms, 1500 mills, 1.7 million power looms and thousands of garments, hosiery, processing units and provides direct or indirect employment for about 60 million people in the country [9]. In India, cotton is cultivated in an area of 12.70 million ha with a production of 30.50 million bales and productivity of 494 kg ha^{-1} lint. The productivity is lower in India compared to world (725 kg ha^{-1} lint). In Karnataka, it is growing in an area of 4.85 lakh hectares with a production of 15.90 lakh bales and productivity of 596 kg ha^{-1} lint [1].

Among the improved agronomic practices, efficient use of nutrient is one of the ways to get higher cotton productivity. Efficient use of nutrient is highly essential for sustainable agriculture, in the context of declining per capita availability of cultivable land, dwindling natural resources, increasing ecological disturbances and escalating cost of fertilizers. Increasing productivity by bringing new land under cultivation has limited scope makes it obligatory to use of nutrients more efficiently.

Fertilizer management of hybrid cotton is differing distinctly from that of varieties. The cotton varieties have generally poor vegetative and reproductive growth than hybrids. The hybrids have much potential to bear a higher leaf area per plant much earlier to varieties and require relatively higher nutrition in early stages. Similarly, the hybrid cotton plant bears more fruiting points and larger bolls. The nutritional demands at various stages of growth of hybrid cotton can ultimately decide the seed cotton yield. A careful planning of schedule, quantity of fertilizers and method of application is needed in case of hybrid cotton in order to obtain higher yield. On an average, cotton crop removes N, P and K at the rate of 125, 24 and 37 kg ha^{-1}, respectively for every 10 bales [11]. So, nitrogen, phosphorus and potassium fertilizers use in cotton production remains important**.** Application of all the three nutrients had effect on lint yield although most of the response was attributed to N (all cultivars) and to some extent P. The results for all quality parameter suggest that K fertilization is a key to better quality [11].

MATERIAL AND METHODS

An investigation entitled ‘‘Effect of nitrogen, phosphorus and potassium levels on yield and economics of interspecific hybrid cotton (*Gossypium spp*) under Southern Dry Zone of Karnataka” was conducted during *Kharif* season of 2016 and 2017 at Zonal Agricultural Research Station, Vishweshwaraiah Canal Farm, Mandya. The soil of the experimental site is sandy loam in texture and neutral in reaction with a pH of 7.27 and normal in electrical conductivity (0.38 dS m^{-1}). The organic carbon content was 0.46 per cent and low in available N (210.54 kg ha^{-1}), medium in available phosphorus (27.48 kg ha^{-1}) and available potassium (152.20 kg ha^{-1}). The trail was laid out in Randomized Complete Block Design (RCBD) with factorial concept and replicated thrice. There were 18 treatment combinations involving three nitrogen levels (N_1-100 kg ha^{-1}, N_2-150 kg ha^{-1} and N_3-150 kg ha^{-1}), two phosphorus levels (P_1-50 kg ha^{-1} and P_2- 75 kg ha^{-1}) and three potassium levels (K_1-50 kg ha^{-1}, K_2-75 kg ha^{-1} and K_3-100 kg ha^{-1}). Farm yard manure was added at the rate of 10 tons ha^{-1} to the experimental site 15 days prior to sowing and was mixed thoroughly. The fertilizers were applied through soil application as per the treatments. The cotton hybrid (DCH - 32) was sown on 22nd June 2016 and 6 th August 2017 with a spacing of 90 cm × 60 cm. The DCH-32 (Jayalakshmi) is world's first interspecific (*G. hirsutum* × *G. barbadense*) and non Bt-hybrid cotton of an extra-long staple developed and released from Agriculture Research Station, Dharwad, Karnataka in 1981 and was a landmark in heteroris breeding. It has the yield potential of 35 q ha^{-1} with ginning per cent of 36, basic staple length of 34.0 - 36.0 mm and the duration of the crop is 190 days. It has spinning count of 80, best suited for Karnataka region and usually grown in Southern Karnataka and Maharashtra. The fertilizer nutrient nitrogen, phosphorus and potassium were applied in the form of urea, SSP and MOP, respectively as per the treatments. The 50 per cent of N, 100 per cent P and K was applied as basal dose at the time of sowing and remaining 50 per cent of nitrogen was top dressed in two splits 25 per cent at 50 DAS and 25 per cent at 75 DAS. The Pendimethalin was sprayed @ 2 ml l^{-1} as pre-emergence spray at 0.75 kg a.i. ha^{-1} and later three Hand weeding were carried out at 15, 30 and 50 DAS. Hoeing operation was carried out at 60 DAS to remove the remaining weeds and also to give support to the base of the crop.

The observations on growth parameters were recorded at 60, 90, 120 DAS and at harvest. Seed cotton yield and stalk yield recorded at harvest and calculated based on the yield obtained from each net plot and converted to kg ha^{-1}and cost benefit ratio was calculated by using gross returns and total cost of cultivation. The data were statistically analyzed by following the method of [5]. The results have been presented and discussed based on pooled data of two years.

RESULTS AND DISCUSSION

Seed cotton yield

Among nitrogen levels (Table 1), Significantly higher seed cotton yield (1857 kg ha^{-1}) and stalk yield (3488 kg ha^{-1}) was recorded with the application of 150 kg N ha^{-1} which was found on par with application of 125 kg N ha^{-1} (1880 and 3381 kg ha^{-1}, respectively), but superior over application of 100 kg N ha^{-1} (1710 and 3212 kg ha^{-1}, respectively). The ginning percentage and seed index were non-significantly differed due to nitrogen levels. The higher levels of nitrogen increased the seed cotton yield and yield attributing character which were attributed to positive effect of nitrogen it controls new growth, increases nutrient uptake and preventing abscission of squares and bolls thereby retaining higher bolls and also due to increased photosynthetic rate which might have resulted in higher accumulation of metabolites. Similar findings were also observed by [3], [2] and [10]. In phosphorus levels, application of 75 kg P_2O_5 ha^{-1} were recorded significantly higher seed cotton yield (2046 kg ha^{-1}) and stalk yield (3844 kg ha^{-1}) with the and superior over application of 50 kg P_2O_5 ha^{-1} (1531 and 2877 kg ha^{-1}, respectively). The higher levels of phosphorus increased the seed cotton yield and yield attributing character may be attributed to increased number of sympodial and monopodial branches would increase the potentiality to bear more leaves which has a positive association between leaf area and leaf area index and in turn it bear more squares since, cotton has auxiliary fruiting habit. These results were in conformity with the findings of [16], [17] and [14]. With respect to potassium levels, significantly higher seed cotton yield (1942 kg ha^{-1}) and stalk yield (3649 kg ha^{-1}) were recorded with the application of 100 kg K_2O ha^{-1} which was found on par with application of 75 kg K_2O ha^{-1} (1861 and 3499 kg ha^{-1}, respectively) superior over application of 50 kg K_2O ha^{-1} (1593 and 2993 kg ha^{-1}, respectively). The higher levels of potassium which increased the seed cotton yield up to 12.97 per cent might be due to potassium requirement of developing bolls are the major sinks of potassium and uptake is limited during this phase. Similar findings were also observed by [15], Jagadish *et al.* (2010), [12] and [6]. The interaction between nitrogen and phosphorus levels (N and P), nitrogen and potassium levels (N and K), phosphorus and potassium levels (P and K) and nitrogen, phosphorus and potassium levels (N, P and K) with respect to yield and yield attributes were found non-significant.

ECONOMICS

Application of 150 kg N ha^{-1} (Table-2) has recorded higher gross returns (Rs. 83,564 ha^{-1}), net returns (Rs. 46,198 ha^{-1}) and B:C ratio (2.23) followed by application of 125 kg N ha^{-1} (Rs. 80,979, Rs. 43,923 and 2.18 ha^{-1}, respectively) superior over application of 100 kg N ha^{-1} (Rs. 76,935, Rs. 40,190, and 2.09 ha^{-1}, respectively). The higher B:C ratio in above treatment was mainly due to the increased seed cotton yield at higher application of nitrogen which in turn increased gross returns. These results are in line with the findings of Gangaiah and Ahlawat (2014), [2] and [14].

Application of 75 kg P_2O_5 ha^{-1} has recorded higher gross returns (Rs. 92,079 ha^{-1}), net returns (Rs. 54,383 ha^{-1}) and B:C ratio (2.44) superior over application of 50 kg P_2O_5 ha^{-1} (Rs. 68,906, Rs. 32,491, and 1.89 ha^{-1}, respectively). The higher B:C ratio in above treatment was mainly due to the increased seed cotton yield at higher application of phosphorus and also better utilization of the inputs which in turn increased gross returns. These results are in line with the findings of [18], [4], [7] and [13]. Application of 100 kg K_2O ha^{-1} has recorded higher gross returns (Rs.87,401 ha^{-1}), net returns (Rs. 49,608 ha^{-1}) and B:C ratio (2.31) followed by application of 75 kg K_2O ha^{-1} (Rs. 83,690, Rs. 46,633 and 2.26 ha^{-1}, respectively) superior over application of 50 kg K_2O ha^{-1} (Rs. 71,687, Rs. 35,369, and 1.97 ha^{-1}, respectively). The higher B:C ratio in above treatment was mainly due to the increased seed cotton yield at higher application of potassium which in turn increased gross returns. These results are in line with the findings of [8] and [14]

The interaction between nitrogen levels and phosphorus levels (N and P), nitrogen levels and potassium levels (N and K), phosphorus levels and potassium levels (P and K) and nitrogen levels, phosphorus levels and potassium levels (N, P and K) with respect to economics were found non-significant (Table 2). However, Numerically higher gross returns, net returns and benefit cost ratio were recorded in treatment combination of 150:75:100 kg NPK ha^{-1} followed by 125:75:100, 100:75:100, 150:75:75 and 125:75:75 kg NPK ha^{-1} over 100:50:50 kg NPK ha^{-1}.

Based on the results of the study following agronomic recommendation can be made for cultivation of hybrid cotton under Southern Dry Zone (Zone 6) of Karnataka. The application of nitrogen 125 kg ha^{-1}, phosphorus 75 kg ha^{-1} and potassium 75 kg ha^{-1} will be beneficial for getting higher seed cotton yield and net returns in interspecific hybrid cotton .

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Table 1: Seed cotton and stalk yield of hybrid cotton as influenced by different nutrient levels at harvest of the crop

Treatments	Seed cotton yield (kg ha^{-1})			Stalk yield (kg ha^{-1})		
	2016	**2017**	**Pooled**	**2016**	**2017**	**Pooled**
Nitrogen (kg ha^{-1})						
N_1-100	1760	1659	1710	3373	3050	3212
N_2-125	1852	1747	1800	3551	3210	3381
N_3-150	1912	1802	1857	3664	3313	3488
S.Em ±	39.97	37.69	34.95	76.61	69.27	65.65
C.D. (p=0.05)	114.87	108.31	100.43	220.19	199.08	188.67
Phosphorus (kg ha^{-1})						
P_1-50	1576	1486	1531	3021	2732	2877
P_2-75	2106	1986	2046	4037	3650	3844
S.Em ±	32.63	30.77	28.53	62.55	56.56	53.60
C.D. (p=0.05)	93.79	88.44	82.01	179.78	162.55	154.05
Potassium (kg ha^{-1})						
K_1-50	1640	1546	1593	3143	2842	2993
K_2-75	1915	1807	1861	3673	3326	3499
K_3-100	1999	1885	1942	3832	3465	3649
S.Em±	39.97	37.69	34.95	76.61	69.27	65.65
C.D. (p=0.05)	114.87	108.31	100.43	220.19	199.08	188.67
Interaction (N×P)						
$N_1 \times P_1$	1485	1400	1442	2846	2573	2709
$N_1 \times P_2$	2035	1919	1977	3901	3527	3714
$N_2 \times P_1$	1602	1510	1556	3070	2776	2923
$N_2 \times P_2$	2103	1983	2043	4032	3645	3838
$N_3 \times P_1$	1643	1549	1596	3149	2847	2998
$N_3 \times P_2$	2181	2056	2118	4180	3779	3979
S.Em±	56.53	53.30	49.42	108.35	97.96	92.84
C.D. (p=0.05)	NS	NS	NS	311.40	NS	NS
Interaction (N×K)						
$N_1 \times K_1$	1533	1445	1489	2939	2657	2798
$N_1 \times K_2$	1843	1737	1790	3532	3193	3362
$N_1 \times K_3$	1904	1795	1850	3650	3300	3475
$N_2 \times K_1$	1670	1574	1622	3200	2893	3047
$N_2 \times K_2$	1896	1788	1842	3634	3286	3460
$N_2 \times K_3$	1992	1878	1935	3818	3452	3635
$N_3 \times K_1$	1717	1619	1668	3291	2976	3133
$N_3 \times K_2$	1916	1806	1861	3672	3320	3496
$N_3 \times K_3$	2102	1982	2042	4029	3643	3836
S.Em±	69.23	65.27	60.53	132.70	119.98	113.71
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS
Interaction (P×K)						

Treatments	Seed cotton yield (kg ha^{-1})			Stalk yield (kg ha^{-1})		
	2016	2017	Pooled	2016	2017	Pooled
P_1×K_1	1318	1243	1281	2527	2285	2406
P_1×K_2	1673	1577	1625	3206	2899	3052
P_1×K_3	1738	1638	1688	3331	3012	3171
P_2×K_1	1961	1849	1905	3759	3399	3579
P_2×K_2	2097	1977	2037	4019	3634	3827
P_2×K_3	2261	2132	2196	4334	3918	4126
S.Em±	56.53	53.30	49.42	108.35	97.96	92.84
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS
Interaction (N×P×K)						
N_1×P_1× K_1	1168	1101	1135	2239	2024	2132
N_1×P_1× K_2	1605	1513	1559	3076	2781	2929
N_1×P_1× K_3	1681	1585	1633	3222	2913	3067
N_1×P_2× K_1	1898	1790	1844	3638	3289	3464
N_1×P_2× K_2	2080	1961	2021	3987	3605	3796
N_1×P_2× K_3	2128	2006	2067	4078	3687	3883
N_2×P_1× K_1	1363	1285	1324	2612	2362	2487
N_2×P_1× K_2	1698	1601	1649	3254	2942	3098
N_2×P_1× K_3	1744	1645	1694	3343	3023	3183
N_2×P_2× K_1	1976	1863	1920	3788	3425	3607
N_2×P_2× K_2	2094	1975	2034	4014	3629	3822
N_2×P_2× K_3	2239	2111	2175	4292	3881	4087
N_3×P_1× K_1	1425	1343	1384	2731	2469	2600
N_3×P_1× K_2	1715	1617	1666	3288	2972	3130
N_3×P_1× K_3	1788	1686	1737	3427	3099	3263
N_3×P_2× K_1	2009	1895	1952	3852	3482	3667
N_3×P_2× K_2	2116	1995	2056	4056	3667	3862
N_3×P_2× K_3	2416	2278	2347	4631	4187	4409
S.Em ±	97.90	92.31	85.60	187.66	169.67	160.80
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS

Nitrogen levels (N)
N_1: 100 kg ha^{-1}
N_2: 125 kg ha^{-1}
N_3: 150 kg ha^{-1}

Phosphorus levels (P)
P_1: 50 kg ha^{-1}
P_2: 75 kg ha^{-1}

Potassium levels (K)
K_1: 50 kg ha^{-1}
K_2: 75 kg ha^{-1}
K_3: 100 kg ha^{-1}

Table 2: Economics of hybrid cotton as influenced by different nutrient levels

Treatments	Gross return (Rs. ha^{-1})			Net returns (Rs. ha^{-1})			Benefit cost ratio		
	2016	2017	Pooled	2016	2017	Pooled	2016	2017	Pooled
Nitrogen (kg ha^{-1})									
N_1-100	79197	74674	76935	42451	37928	40190	2.15	2.02	2.09
N_2-125	83360	78598	80979	46304	41542	43923	2.24	2.11	2.18
N_3-150	86020	81107	83564	48655	43741	46198	2.29	2.16	2.23
S.Em ±	1799	1696	1747	1799	1696	1747	0.048	0.045	0.047
C.D. (p=0.05)	5169	4874	5022	5169	4874	5022	0.138	0.130	0.134
Phosphorus (kg ha^{-1})									
P_1-50	70932	66880	68906	34516	30465	32491	1.94	1.83	1.89
P_2-75	94786	89372	92079	57090	51676	54383	2.51	2.37	2.44
S.Em ±	1469	1385	1427	1469	1385	1427	0.04	0.04	0.04
C.D. (p=0.05)	4221	3980	4100	4221	3980	4100	0.11	0.11	0.11
Potassium (kg ha^{-1})									
K_1-50	73794	69579	71687	37477	33262	35369	2.02	1.91	1.97
K_2-75	86112	81268	83690	49056	44211	46633	2.32	2.19	2.26
K_3-100	89971	84832	87401	52177	47038	49608	2.38	2.24	2.31
S.Em ±	1799	1696	1747	1799	1696	1747	0.048	0.045	0.047
C.D. (p=0.05)	5169	4874	5022	5169	4874	5022	0.138	0.130	0.134
Interaction (NXP)									
N_1**X**P_1	66806	62990	64898	30701	26885	28793	1.85	1.74	1.79
N_1**X**P_2	91588	86357	88973	54202	48971	51586	2.45	2.31	2.38
N_2**X**P_1	72072	67955	70014	35657	31540	33598	1.98	1.86	1.92
N_2**X**P_2	94647	89241	91944	56951	51545	54248	2.51	2.37	2.44
N_3**X**P_1	73917	69695	71806	37192	32969	35081	2.01	1.90	1.95
N_3**X**P_2	98124	92519	95321	60117	54513	57315	2.58	2.43	2.51
S.Em ±	2544	2398	2471	2544	2398	2471	0.068	0.064	0.066
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (N×K)									
$N_1 \times K_1$	68987	65047	67017	32980	29039	31009	1.91	1.80	1.85
$N_1 \times K_2$	82914	78178	80546	46167	41431	43799	2.25	2.12	2.19
$N_1 \times K_3$	85691	80796	83244	48207	43313	45760	2.28	2.15	2.22
$N_2 \times K_1$	75128	70837	72983	38811	34519	36665	2.06	1.94	2.00
$N_2 \times K_2$	85320	80447	82883	48263	43390	45827	2.30	2.17	2.23
$N_2 \times K_3$	89631	84511	87071	51837	46718	49277	2.37	2.23	2.30
$N_3 \times K_1$	77267	72854	75061	40640	36226	38433	2.10	1.98	2.04
$N_3 \times K_2$	86203	81279	83741	48836	43912	46374	2.30	2.17	2.24
$N_3 \times K_3$	94591	89188	91890	56488	51085	53786	2.48	2.34	2.41

S.Em ±	3115	2937	3026	3115	2937	3026	0.083	0.079	0.081
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (P×K)									
P_1×K_1	59331	55942	57637	23654	20265	21960	1.66	1.57	1.61
P_1×K_2	75267	70968	73118	38851	34552	36702	2.07	1.95	2.01
P_1×K_3	78197	73730	75964	41044	36577	38811	2.10	1.98	2.04
P_2×K_1	88257	83216	85737	51299	46258	48779	2.39	2.25	2.32
P_2×K_2	94357	88968	91662	56660	51271	53965	2.50	2.36	2.43
P_2×K_3	101745	95933	98839	63311	57499	60405	2.65	2.50	2.57
S.Em ±	2544	2398	2471	2544	2398	2471	0.068	0.064	0.066
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Interaction (N×P×K)									
N_1×P_1× K_1	52562	49559	51061	17195	14192	15694	1.49	1.40	1.44
N_1×P_1× K_2	72220	68095	70157	36114	31989	34051	2.00	1.89	1.94
N_1×P_1× K_3	75637	71317	73477	38794	34474	36634	2.05	1.94	1.99
N_1×P_2× K_1	85413	80534	82973	48765	43886	46325	2.33	2.20	2.26
N_1×P_2× K_2	93608	88261	90934	56221	50874	53547	2.50	2.36	2.43
N_1×P_2× K_3	95745	90276	93010	57621	52152	54886	2.51	2.37	2.44
N_2×P_1× K_1	61324	57821	59573	25647	22144	23896	1.72	1.62	1.67
N_2×P_1× K_2	76401	72037	74219	39985	35621	37803	2.10	1.98	2.04
N_2×P_1× K_3	78491	74008	76249	41338	36855	39096	2.11	1.99	2.05
N_2×P_2× K_1	88932	83852	86392	51974	46894	49434	2.41	2.27	2.34
N_2×P_2× K_2	94239	88856	91548	56542	51159	53851	2.50	2.36	2.43
N_2×P_2× K_3	100770	95014	97892	62336	56580	59458	2.62	2.47	2.55
N_3×P_1× K_1	64108	60446	62277	28121	24459	26290	1.78	1.68	1.73
N_3×P_1× K_2	77181	72772	74976	40455	36046	38250	2.10	1.98	2.04
N_3×P_1× K_3	80462	75866	78164	42999	38403	40701	2.15	2.03	2.09
N_3×P_2× K_1	90427	85262	87844	53159	47994	50576	2.43	2.29	2.36
N_3×P_2× K_2	95225	89786	92505	57218	51779	54498	2.51	2.36	2.43
N_3×P_2× K_3	108720	102510	105615	69976	63766	66871	2.81	2.65	2.73
S.Em ±	4406	4154	4280	4406	4154	4280	0.118	0.111	0.115
C.D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Nitrogen levels (N)
N_1: 100 kg ha^{-1}
N_2: 125 kg ha^{-1}
N_3: 150 kg ha^{-1}

Phosphorus levels (P)
P_1: 50 kg ha^{-1}
P_2: 75 kg ha^{-1}

Potassium levels (K)
K_1: 50 kg ha^{-1}
K_2: 75 kg ha^{-1}
K_3: 100 kg ha^{-1}