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Cultural Practices to Combat Degradation under Rainfed Areas in the Northern Coastal Plain in Egypt

Ahmed Kamel

Agricultural Research Center (ARC), Giza, Egypt

Abstract: The rainfed areas in the Northern Western Coastal plains extends over vast areas from western part of Alexandria towards the west at Salloom near the Libyan borders. Rates of rainfall are very poor ranging from 100 m/yr in the east and 150-200 mm/yr in the west. Rainfall decreases from the seashore to inwards the desert for 15 km to reach only 50 mm/yr. Major constraints which threaten agricultural sustainability are very low and unpredictable rainfall, poor soil moisture retention lack of organic matter, cereal monocropping, wind erosion and overgrazing in the rangelands. Crop diversification (inclusion of legume in particular) and fertility build up are the main research priority. These studies included three field trials. The first to combat wind erosion and built up fertility in silvi culture areas near the sea. Drought tolerant lentil was intercropped with the new olive trees. The results were in favor drilling method and yielded the best as compared with broadcasting in no till or tillage system. The second trial was conducted inwards 15 km from the sea to conserve rainfall water (75-125 mm/yr). Barley seeding rates was examined under different ploughing depths. The results indicated that low seeding rate (48 kg/fed) with the shallow tilth (20 cm depth) yielded the best. The third trial in same area was devoted to build up fertility by the inclusion of legume in intercropping lentil with barley. Lentil with barley in equal alternative system (2:2) rows resulted in better yields of both crops and build up fertility.

Key words: Rainfed areas · Lentil · Barley · Intercropping · Moisture conservation

INTRODUCTION

The rainfed areas in the Northern Western Coastal plains extend over vast areas from western part of Alexandria towards the west at Salloom near Libyan borders. Rates of rainfall are very poor ranging from 100 mm/yr in the east and 150-200 mm/yr in the west. Rainfall decreases from the sea shore inwards the deserts for 15 km to reach only 50 mm/yr. Major constraints which threaten agricultural sustainability are; very low and unpredictable rainfall, poor soil moisture retention, lack of organic matter, cereal monocropping,monocropping, wind erosion and overgrazing in rangelands. The study covers the major zones (Zone I, II) according to variations in monthly rainfall in quantity and distribution. In the coastal plain near the sea (zone I) which extend 10 km towards the desert, 90% of the area (75 thousand hectares) is occupied by solid fig and olive trees where the rate of rainfall (200-150 mm/yr) is relatively high. Further, south inwards the desert and where the total area is almost dependent on rainfall, barley crop dominates the crop structure. Agricultural Development and Crop Intensification Research Project Program (CIRP) included three field trials to offer effective means to combat degradation and desertification in these regions. The first field trial aims to offer farmers new cropping system by intercropping their orchards with lentil to conserve moisture content in the soil, combat wind erosion and increase soil fertility. The second trial in zone II was to examine optimum tillage depth to conserve moisture content where the total area is almost dependent on poor rainfall and where barley dominate crop structure. The third trial was conducted in zone II to enrich soil by mixed cropping barley with legume to check weed growth and to increase productivity per unit of land.

First Field Trial (Zone I)

Intercropping Fig with Lentil: Lentil as legume has great benefit to the poor soil by increasing nitrogen fixation. Lentil is adapted under rainfall condition. [1-5] intercropped lentil with peach under rainfall conditions in North Sinai and they found that intercropping lentil with peach trees increased fruit either per tree or per unit of land and increased soil fertility.

Corresponding Autor: Ahmed Kamel, Agricultural Research Center (ARC), Giza, Egypt

Table 1: Rainfall and relative humidity data during 2006 and 2007…….???

Month	Nov.		Dec.		Jan.		Feb.		Mar.		Apr.		May.	
year	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Rainfall mm	1.7	2.6	14.8	14.0	68.0	33.1	49.0	42.0	15.7	16.8	3.0	2.0	2.0	1.6
Relative humidity%	70.1	70.1	63.0	72.0	73.0	75.0	71.1	73.0	75.4	60.0	63.3	64.0	62.0	65.0

Total rainfall in the year 2006 was amounted to 154 mm and in the year 2007year 2007 of 142 mm

Methodology: The treatments comprised methods of sowing (drilling, broadcasting without tillage and broadcasting with tillage), two seed rates of lentil (30 and 20 kg/fed.) and two treatments of inoculation with *Rhizobium spp*; inoculated and uninoculated. Treatments were laid out in Split Plot design in solid state and interplanted under fig trees. Plot size was 1/50 fed (84 m^2). Lentil seeds were drilled or broadcasted as strips 30 cm apart between rows of fig trees. The seeds of lentil were sown directly in ploughed soil after the first adequate rainfall which secured moisture content enough for germination and sustainable growth, whereas, seeds were sown in unploughed soil to represent broadcasting without tillage. Sowing was carried out in December 25 and January 10 in the two successive seasons in 2006 and 2007, respectively. The amounts of rainfall were recorded in the following table 1.

The data collected were statistically analysed by using computer statistical program MSTATprogram MSTAT-C [6]. Fishers analysis of variance technique was employed by [7] and the least significant difference LSD at 0.05 was used to compare the treatment means.

RESULTS AND DISCUSSION

Sowing Methods: Sowing lentil by drilling had significantly higher number of nodules, seed and straw yield/fed, harvest index and protein percent of both pure stand and intercropped in both seasons (Table 2 and 3). Drilling may enable proper sowing depth and good seed germination.

Seeding Rates: Lower rate of seeding (20 kg/fed) significantly increased nodules/plant, whereas, Seeds and straw yields/fed, harvest index and protein percent in seeds, were increased with increasing seed rate to 30kg/fed. The increases in yields of lentil might be due to increasing number of plants/fed. Interplanting lentil under fig trees responded more positive rather than solid planting. The obtained results are in agreement with Sharma *et al*, [8], Ashour *et al,* [4] and [5], Banik *et al*. [9] and Abd El- Zaher *et al*. [10].

Inoculation with *Rhizobium Leguminosarum*: Rhizobium treatment increased all afromenioned traits and caused increases in seed yield/fed which was estimated on average of both seasons to 17.20 and 12.25% in interplanting and solid, respectively and indicating that inoculation was more effective in interplanting rather than solid planting. These results were supported by [1, 2, 11, 12].

Interaction Effect: Significant interaction effects of sowing methods and seeding rate on seed yield of lentil was observed. Highest seed yield/fed was obtained by solid and interplanting when lentil seeds were drilled with both seeding rates (Table 4).

Fig Yield: Fig yield per tree or per fed. was higher in the two successive seasons when lentil was interplanted with (Table 5). This may be due to increase fertility through the formation of nodules and increasing nitrogen content in soil and more conservation of water in different layers of soil profile. Similar resultes were reported by Banik *et al*, [9] and Abdel Zaher *et al*, [10].

Second Field Trial (Zone Ii)

Optimizing Ploughing Depth and Rate of Seeding: To increase water harvested in soil profile, special agrotechniques in farming system to provide the plants with adequate supply of water is of great importance. This study was devoted to evaluate different ploughing depths and different seeding rates on yield and some yield components of barley in three locations; Sidi Barani, EL-Washak in North Western Coastal plains and Rafah in Sinai.

Methodology: The treatments were no tillage, ploughing at 20 and 40 cm depth and seeding rates were 48, 60 and 72 kg/ha. Sowing dates were 14 and 15 November in 2006 and 2007, respectively. No irrigation or fertilizer were added and the old national Giza 123 cultivar was used. (The cultivar the Bedouins frequently use). Treatments were assigned in split plot design. The plot size was 1/80 of fed. The combined analysis of variance over all

Table 2: Average number of nodules/plant of lentil interplanted with fig under rainfed conditions in North - west coast in the two seasons (2006/2007)

	No. of nodules /plant			
Treatments	Solid	Interplanting	Solid	Interplanting
A:Sowing methods				
Drilling	59.1	62.8	62.2	64.9
Broadcasting (no till)	47.7	51.3	51.7	55.1
Broadcasting (till)	50.6	53.4	54.9	58.0
F.test	--(1)	--	--	--
L.S.D. 0.05	2.4	2.7	2.1	1.7
B: Seeding rates				
30 kg/fed	51.3	54.7	54.2	57.3
20 kg/fed	53.6	57.0	58.3	61.2
F.test	--	--	--	--
C: inoculation				
Untreated	47.6	50.9	51.1	53.9
Treated	57.3	60.8	61.4	64.6
F.test	--	--	--	--
Interaction				
A× B	--	*(2)	--	--
A× C	*	*	--	--
B× C	--	--	--	*
A× B× C	--	--	--	*

N.B. (1) Insignificant. (2) Significant.

Table 3: Averages of seed and straw yields/fed., Harvest index% and protein percentage of Lentil interplanted with fig trees under rain-fed conditions in North west coast in the two seasons (2006/2007)

	Seed yield (ardab/fed)				Straw yield (ton/fed.)				Harvest index%				Protein%			
	2006		2007		2006		2007		2006		2007		2006		2007	
Treatments	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.
A:Sowing methods																
Drilling	1.863	1.928	1.841	1.897	1.176	1.218	1.258	1.302	62.5	60.5	59.3	59.6	20.5	21.2	21.7	22.4
Broadcasting (no till)	1.400	1.469	1.288	1.334	0.914	0.959	1.044	1.073	60.3	61.0	54.7	55.0	17.8	18.6	20.7	21.4
Broadcasting (till)	1.575	1.631	1.477	1.528	1.096	1.122	1.156	1.208	64.9	59.1	55.7	55.8	18.4	19.3	20.0	20.8
F.test	--(1)	--	--	--	--	--	--	-	--	--	--	--	--	--	--	--
LSD 5%	0.2	0.2	0.1	0.1	0.1	0.1	0.05	0.04	0.4	0.6	0.9	0.8	0.8	1.1	0.7	0.8
B: Seeding rates																
30 kg/fed	1.712	1.777	1.698	1.744	1.110	1.152	1.197	1.242	61.1	60.6	58.2	58.5	18.5	19.3	20.5	21.3
20 kg/fed	1.513	1.575	1.372	1.429	0.994	1.048	1.108	1.150	60.5	60.1	55.4	55.6	19.2	20.1	21.1	21.9
F.test	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
C: Inoculation																
Untreated	1.492	1.544	1.370	1.417	0.977	1.0231	1.088	1.137	60.2	60.4	55.7	55.3	16.3	17.0	18.2	19.0
Treated	1.733	1.808	1.700	1.756	1.127	1.217	1.217	1.256	60.6	70.1	67.5	58.5	21.5	22.3	23.4	24.1
F.test	--	--	--	--	--	--	--	-	--	--	--	--	--	--	--	--
Interaction																
A× B	**(2)	**	**	*(3)	--	--	--	*	--	--	--	--	*	--	**	**
A× C	**	**	**	*	--	--	*	--	--	--	*	--	**	**	**	**
B× C	**	**	**	**	--	*	**	**	*	*	--	--	**	**	*	--
A× B× C	**	**	**	**	--	--	**	**	--	--	--	--	--	--	--	--

N.B. (1) Insignificant. (2) High Significant. (3) Significant

Table 4: Averages of seed yields (ardab/fed.) of Lentil interplanting with fig trees as affected by the interaction between sowing methods and seeding rates under rainfed conditions in North west coast in the two seasons (2006/2007)

	2006				2007			
	30 kg/fed		20 kg/fed		30 kg/fed		20 kg/fed	
Seeding rates								
Sowing methods	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.	Sol.	Inter.
Drilling	2.019	2.094	1.706	1.762	2.000	2.031	1.681	1.763
Broadcasting (no till)	1.487	1.550	1.313	1.388	1.306	1.556	1.107	1.113
Broadcasting (till)	1.631	1.688	1.519	1.575	1.587	1.644	1.366	1.412
LSD at 0.05	0.08				0.10			

Table 5: Averages of productivity of fig trees interplanted with lentil under rainfed conditions in North west coast in the two seasons (2006/2007)

	Yield of fig fruits					
	2006		2007		Mean	
Crop Pattern	kg/tree	ton/fed	kg/tree	ton/fed	kg/tree	ton/fed
Solid fig	43.500	3.655	42.300	3.420	42.900	3.537
Lentil + fig	46.170	3.910	44.500	3.860	45.600	3.885

Table 6: Monthly distribution of rainfall and seasonal rainfall (% S.R.F.) for barley growing season, (2006/2007)

		Month							
Location	Rainfall mm	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Seasonal Rainfall mm
Sidi Baraini	Amt. mm	11.0	146.0	29.3	1.1	26.1	8.8	4.0	226.3
	% S.R.F.	4.9	64.3	12.9	0.5	11.5	3.9	1.8	100
El-Washak	Amt. mm	8.0	109.0	39.0	6.5	23.3	8.5	4.5	198.8
	% S.R.F.	4.0	54.8	19.6	3.3	11.7	4.3	2.3	100
Rafah	Amt. mm	7.0	130.3	60.1	23.7	25.3	6.4	7.7	260.5
	% S.R.F.	2.7	50.0	23.1	10.6	8.7	2.5	3.0	---

locations using least significant difference (LSD) were performed to estimate significance among the treatment imposed [7]. Monthly distribution of rainfall and seasonal rainfall are presented in Table 6.

RESULTS AND DISCUSSION

Location: The results in table 7 indicate that location had significant effects on yield and yield components of barley, except harvest index. Rafah location gave highest values for all traits. This might be attributed the increase in rainfall in Rafah.

Ploughing Depth: Ploughing depth, significantly affected the yield components of barley. The highest values resulted from the deep ploughing (40 cm) except for 1000 KWt. The percent increase reached 102% for grain yield/ha. These results were coincided with those obtained by Ibrahim *et al*. [13]. Deep ploughing fractionates the hard pan in the soil profile which allow the rainfall to penetrate soil profile and being stored in the deep layer and provide available water content in the soil throughout growing season (Table 7).

Seeding Rates: Seeding rates had also significant effect on the yield components of barley (table 7). The lowest rate (48 kg/ha) was associated with highest records for all traits, except for 1000 KWT. In this regard, Finlay *et al*. [24] found insignificant differences between using 54 and 161 kg seeds/ha for spring barley in the dry land of Montana in U.S.A.

Interaction: Combined analysis showed that there were significant effect for the interaction of location and ploughing depths on yield and yield components except for HI. The highest value was obtained from Rafah location when ploughing depth was at 40 cm (Table 8). Recommendations that could be elucidated from these results are to plough deep enough to increase water availability in the soil profile through barley lifetime and to use the lower seeding rate (48 kg/ha).

Table 7: Means of yield and yield components of barley grown at three locations in the North Coastal area under rainfed conditions, 2006/2007)

Location /Treatments	Spike grain wt g	1000 KWT g	Grain yield kg/ha	Harvest Index
Loctions				
Sidi Barani	1.62	41.0	1007	0.351
EL-Washak	1.15	39.9	689	0.342
Rafah	2.16	46.9	1691	0.331
LSD 5%	0.26	1.6	141	NS
Ploughing depth				
No tillage	1.28	40.1	713	0.323
20 cm	1.79	44.8	1231	0.357
40 cm	1.86	42.9	1443	0.345
LSD 5%	0.26	1.6	141	NS
Seeding rate				
48 kg/ha	1.68	42.5	1173	0.343
60 kg/ha	1.60	42.3	1092	0.341
72 kg/ha	1.65	43.0	1123	0.341
LSD 5%	NS	NS	NS	NS
CV%	23.4	8.1	17.9	15.4

Table 8: Interaction effect of locations and ploughing depth on vegetative growth characters and yield components of barley grown at three locations in the North Coastal area and Sinai under rainfed conditions (2006/2007)

Location /Treatments	PLHT[(1)] (cm)	S.L.[(2)] (cm)	No till/plant	SY[(3)] (Kg/ha)	BY[(4)] (Kg/ha)	Spike Wt (g)	1000-K Wt[(5)] (g)	Grain yield (kg/ha)	Harvest index	A moisture depietion (%)
Sidi Barani										
00	24.2	2.12	1.25	825	1192	1.37	39.1	367	0.309	2.90
20	49.6	4.44	2.28	214 8	3473	1.84	44.1	1326	0.384	3.24
40	51.1	4.43	2.33	2382	3709	1.66	39.8	1328	0.359	3.40
EL-Washak										
00	15.3	1.75	1.83	942	1233	0.67	33.6	292	0.301	1.93
20	40.1	3.64	2.22	1353	2075	1.53	44.6	723	0.354	2.44
40	41.6	4.07	2.58	1738	2790	1.25	41.7	1052	0.372	2.60
Rafah										
00	54.2	4.86	1.50	2679	4159	1.81	47.8	1480	0.358	3.20
20	54.2	4.94	1.49	3279	4925	2.01	45.7	1646	0.332	3.60
40	57.3	5.49	1.82	4611	6559	2.67	47.2	1948	0.304	4.12
CV%	8.8	12.6	24.5	21.7	15.9	23.4	8.1	17.9	15.4	--
LSD 5%	4.7	0.53	0.43	0.43	839	979	0.44	2.8	244	NS

N.B. [(1)] Plant height. [(2)] Spike length. [(3)] Straw yield. [(4)] Biological yield. [(5)] 1000 Kernel weight.

Third Field Trial (Zone Iii)

Intercropping Barley with Lentil: Mixed cropping is considered an effective measure for the improvement of rainfed arable farming under traditional farming crops. Mixtures of crops have advantages in checking weed growth, avoid risk of weather fluctuation, epedimic diseases and attack of insects, reducing and spreading labour demand and providing greater assurance of food supply, in addition, increase productivity per unit of land. Few studies were conducted on mixtures of barley in Egypt. The yields of berseem-barley mixture as forage crops were higher than the legume or cereal in pure stand [14, 15]. In a well-balanced cereal-legume, the amount of N fixed by the legume is commonly in the range of 112-224 kg/N/ha/ year. With a long growing seasons and favourable temperature and moisture under rainfed conditions, as much as 600 N/ha was transferred from legume to grass in the same season and it was demonstrated that legume have resistance to drought due to their relative deep rooting habit [16]. They also found that where legumes are interplanted in cereal, highest plant densities of cereal can reduce light intensities and increase the moisture stress experienced by the legume, the plant population and the spatial arrangement of the plants in mixed cropping may affect N fixation. Andrew, [17] and El-Sayed and Noaman, [18] found also that the yield advantage of the mixture over pure stand was greatest when the two crops were planted in equal alternative rows and was progressively diminished by altering one row of one crop with two rows of the other.

Methodology: The field trial included seven treatments to examine five intercrop combinations in alternative systems barley: lentil (1:1), (2:1), (2:2), (3:2) and were checked against pure stands of barley and Lentil. The treatments were assigned in complete randomized block systems and were conducted in 2007 and 2008 seasons. They were tested in four locations deep in the desert (20 km from the sea) only one location west of El-Mathani village that the plants could survive but poorly grew in both seasons since the average rainfall were 150 and145 mm/yr for both successive seasons,respectively. Barley the cereal yielded both grain and straw but lentil the legume failed to yield mature seeds, but the foliage was used as hay for sheep and goats. Grains and seeds of both components were seeded on 29 and 30 November for both successive seasons, respectively. Plot size was 1/50 fed (84 m^2) barley CV.Giza 126 and lentil CV.Giza 370 were used in the mixture. Competition functions as land equivalent ratio (LER), relative crowding coefficient (RCC) and agressivity (A) were calculated according to Willey, [19], Dewit, [20] and Mc. Gilchrist, 1965, respectively. The combined analysis of variance using least significant difference (LSD) was performed to estimate significance among the treatment imposed [7].

RESULTS AND DISCUSSION

Barley: The data on barley indicate that growth and yield component traits of barley in equal alternative row pattern (2:2) tended to be superior to all other treatments except spike length and number of plants/m^2 (Table 9) Data on the adjusted yield indicated also that the equal alternative row patterns (2:2) and (1:1) gave the first and second yields of grains and straw (Table 10). The results were supported by the results obtained by Abd El-Zaher *et al*. [22] and Mudita *et al*. [23]. They reported that strip cropping systems were ever superior to single alternative systems.

Lentil: Lentil plant could survive under the very dry season, but failed to terminate with mature seeding. The only data recorded on lentil were the average number of survival plants/m^2 and the air dried weight of foliage. The data obtained on the latter traits indicated that the equal alternative row patterns (2:2) and (1:1) gave the first and second dry weight of lentil plants/ha but were still lower than lentil grown in pure sand. (3:2), (3:1) and (2:1) patterns ranked the fourth, fifth and sixth,respectively (Table 10).

Table 9: Averages of growth attributes of barley lentil plants grown in mixtures and pure stand under rainfed

	Barley							Lentil		
Intercrop combinations	Plant height (cm)	Number of tillers/plant	Spike length (cm)	Straw weight/ plant (g)	Spike weight/ plant (g)	Grain weight/ spike (g)	1000 kernel weight (g)	Number of plants/m^2	Number of plants/m^2	Dry weight/ plant (g)
1: 1	30.313	1.625	3.75	1.177	1.355	1.150	32.250	62.000	32.250	1.511
2: 1	31.875	1.313	4.000	1.270	1.470	1.130	34.500	39.250	16.500	1.475
2: 2	32.875	1.688	3.938	1.623	1.740	1.330	38.00	57.500	32.750	1.555
3: 1	29.250	1.625	4.000	1.098	1.447	1.173	26.250	66.500	19.500	1.610
3: 2	28.125	1.500	3.813	0.938	1.140	1.085	30.000	58.000	23.000	1.670
Solid	26.063	1.250	3.250	1.023	1.337	0.975	32.500	76.000	47.500	1.640
LSD at level 5%	4.092	0.736	0.974	0.304	0.547	0.414	0.420	10.308	8.319	---

Table 10: Actual and Adjusted yield of barley as influenced by some intercrop combination

	Grain yield (ton/ha)		Straw yield (ton/ha)	
Intercrop treatment	Actual	Adjusted	Actual	Adjusted
1: 1	0.577	1.154	0.725	0.967
2: 1	0.455	0.683	0.508	0.762
2: 2	0.758	1.516	0.590	1.180
3: 1	0.775	1.033	0.925	0.850
3: 2	0.620	1.033	0.542	0.903
Solid	0.585	0.585	0.612	0.612

Table 11: Competitive relationship of barley with lentil as influenced by different intercrop combinations under rainfed conditions

Intercrop combinations	Land Equivalent Ratio (LER)			Relative Crowding Coefficient			Aggressivity	
	RY_b[(1)]	RY_l[(2)]	LER	K_b	K_l	RCC	A_{bl}	A_{lb}
Barley: Lentil								
1: 1	0.94	0.64	1.58	15.27	2.16	11.10	+ 0.60	-0.60
2: 1	0.64	0.38	1.02	0.88	1.22	1.08	+ 1.38	-1.38
2: 2	1.20	0.64	1.84	5.99	1.74	26.60	+ 1.11	- 1.11
3: 1	0.94	0.42	1.36	5.15	1.81	10.82	+ 3.2	- 3.2
3: 2	0.70	0.48	1.18	1.55	1.36	2.11	+ 0.96	- 0.96

N.B. [(1)] Barley. [(2)] Lentil.

Competition Functions: Data in Table 11 indicated that the relative yield (RYs) of barley straw was ever higher than those calculated of lentil. The excesses in RYs of barley in all mixtures are due to the possible transference of nitrogen from legume to cereal, an observation that has been previously demonstrated by Thomas [25]. RYs of lentil, on the other hands, seemed to be more adversely influenced by drought.

Data on land utilization rate revealed that both patterns (2:2) and (1:1) gave the highest land use efficiency. Abdel Zahar *et al* [22] and Mudita *et al* [23] supported these results. Both patterns recorded 84 and 58 more efficiency compared to solid planting. These results are in agreement with those obtained by Andrew [17] and could be interpreted as due to better spatial arrangement which offer both crops maximum benefit from solar radiation as well as water and nutrients from below ground. The data also revealed 36% and 18% more efficiency when (3:1) and (3:2) were applied whereas (2:1) pattern did not achieve any yield advantage compared with solid planting of either component. RCC values of all mixtures exceeded the unit indicating yield advantage. (2:2) and (1:1) followed the same general tendency and were the favourest. Aggressivity data indicated that barley was ever the dominant component, whereas lentil was the dominated. Maximum value was recorded when (3:1) pattern was applied where barley plant had the heaviest competitive pressure on lentil whereas least value of aggressivity was obtained when (1:1) pattern was applied.

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