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Effect of supplementary irrigation scheduling on growth, yield components and quality of faba bean (vicia faba .L) Under El- Osaita conditions, Libya

Thahib K Mohammed[1*], Ibtisam O Erfad[2], Jamila S Mohammed[3]
[1,2,3]Department of Crops, Faculty of Agriculture, Omar Al-Mukhtar University, Al Bayda, Libya

تأثير الرأي التكميلي على نمو ومكونات الإنتاج وجوده القول البلدي *(faba Vicia)* تحت ظروف الوسيطة ليبيا

ذهب محمد خليفة[1*]، ابتسام عثمان أرفاد[2]، جميلة سعد محمد[3]
[1،2،3]قسم المحاصيل، كلية الزراعة، جامعة عمر المختار، البيضاء، ليبيا

*Corresponding author: abtisam140037@gmail.com

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Abstract:
A field study was conducted over two growing seasons at El- Osaita Libya, to evaluate the impact of supplementary irrigation (sp) regimes on the performance of faba bean (vicia faba .L) under semi-arid conditions. Three irrigation treatments were tested: rainfed (no irrigation), supplementary irrigation every 7 days and every 21 days. The experiment was arranged in randomized complete block design with four raplications, Results revealed that plant height, pod length, seed number per pod, seed weight, seed number and weight per plant and 100-seed were significantly improved under sp every 7 days compared to rainfed, conditions. Notably, the highest (103. 40cm), pod length (16.2 cm), seed number per pod (5.7), and seed weight of plant (35.1 g) ware recorded under 7 days treatment, Economic and biological yields were also significantly enhanced in the 2nd season under frequent irrigation, The harvest index and seed protein content showed marked improvement, with protein percentage up to 24. 65% in the first season. The study concludes that regular sp irrrgation every 7 days, enhances vegetative, and growth, yield components, and seed quality of faba bean in semi-arid environments. Therefore, adopting a 7- day irrigation interval is recommended to improve productivity under similar agro-climatic conditions.

key words: faba bean, supplementary irrigation.
hitectural Education, Digital Drawings, Digital Architectural Design, Educational Technology.

الملخص:
أجريت دراسة حقلية خلال موسمين زراعين في منطقة الوسيطة، ليبيا لتقييم تأثير نظم الري التكميلي على أداء محصول الفول البلدي (faba Vicia) تحت ظروف شبه جافة، شملت التجربة ثلاثة نظم للري: الزراعة البعلية (دون ري)، والري كل 7 أيام والري كل 21 يوم، ثم تنفيذ التجربة وفق تصميم القطاعات العشوائية الكاملة (RCHD) بأربعة مكررات، أظهرت النتائج أن الري كل 7 أيام أدى إلى زيادة معنوية في ارتفاع النبات، طول القرن، عدد بذور القرن، ووزن بذور القرن، ووزن بذور النبات ووزن 100 بذرة مقارنة بالزراعة البعلية، وسجلت أعلى القيم في نظام الري كل 7 أيام حيث بلغ ارتفاع النبات 103.40 سم، وطول القرن 16.2 سم وعدد بذور القرن 5.7 ووزن بذور النبات 35.1 جم كما تحسن المحصول البيولوجي والبذور بشكل واضح في الموسم الثاني، وأظهرت دليل الحصاد ومحتوى البذور من البروتين زيادة

ملحوظة إذ بلغت نسبة البروتين 24.65% في الموسم الأول، توصي الدراسة باعتماد الري التكميلي كل 7 أيام الزيادة الإنتاج وجودة محصول القول البلدي تحت ظروف الشبه جافة المشابهة الظروف منطقة الوسيطة.

الكلمات المفتاحية: القول البلدي، الري التكميلي.

Introduction:

faba bean (Vicia faba. L) is a major leguminous crop cultivated for its high protein content its beneficial role in sustainable agriculture through nitrogen fixation, yassein *et al*,. 2022. In semi- arid zones, where rainfall is limited and irregular water availability becomes a critical factor influencing crop productivity, Doorenbos and Kassam, 1979: Faba bean is particularly sensitive to water stress, especially during key growth stages such as flowering and pod filling, which significantly affects yield components like ike pod number, seed size, and overall biomass, manal *et al*. 2022-Water scarcity in semi-arid environments not only limits physiological processes such as photosynthesis and nutrient uptake but also reduces nodulation and biological nitrogen fixation, Amany *et al*., 2025. W

Therefore, understanding the crop's water requirements and implementing appropriate water management strategies such as supplementary irrigation are essential to maximize yield and maintain soil fertility in these regions. Daryanto *et al*., 2017.

This study explores the response of faba bean to different water regimes in El- osiata as a semi- arid environment, aiming to optimize water use efficiency and improve crop resilience under El- Osiata climate.

Materials and methods:

Two field experiments were conducted under the agricultural climatic conditions of El- Osaita located at latitude 32.34° N and longitude 21.39° E, with an altitude of 365 meters above sea level.

The objective was to evaluate the effect of supplementary irrigation (sp) regimes applied every 7 and 21 days in comparison to rainfed conditions. The total annual rainfall recorded during the two seasons 2020-23 and 2023-24 was 318. 19 and 233.34 mm, respectively. The meteorological data for the study area are presented in table 1. Soil analysis revealed that the experimental soil was clay in texture. The soil PH was 7.57, electrical conductivity (EC) was 0.191 sd/m, and the cation exchange capacity (CEC) was 27.80 meq/100g.

The organic matter (OM) content ranged from 3.12% to 4% while calcium carbonate ($Caco_3$) content varied between 13.93 % and 34.58% the field capacity was recorded as 26.29% and 28.46%, and the witting point as 9.6% and 3.48%, resulting in available water content of 16.67% and 4.98%, respectively, the soil water content was mersured at 12.86% and 13.38%, while soil bulck density was 1.19 g/cm³ and 2.1 g/cm³ the crop used in this study was fab bean (vicia faba) using a local verity chariety charachetized by pigmented stems and broad seeds. Sowing was carried out in 15th and 13th November in the first and second season, respectively in rows, the 30 cm a parts and plant in rows 20 cm a part experimental design followed a ranomized complete Block design (RCBD) with four replications: Each experimental united had an area of 3 m x 4 m (12 m)². Before sowing, diammonium phosphate (DAP, 18: 46) was applied at rate of 50 kg/ha as a basal fertilizer. Sp was applied at two intervals: every 7 days and every 21 days, starting from sowing and continuing until physiological maturity. A thrid treatment.

Table (1): Annual monthly rainfall, Relative humidity, maximum and minimum temperature and day length of El- Osaita area during first season 2022-23 and second season 2023-24.

Month	Annual Rainfall Mm		Relative Humidity %		Temperature Co				Sunshine hours per day	
					Maximum		Minimum			
	1st season	2nd	1st season	2nd	1st season	2nd	1st season	2nd	1st season	2nd
Oct	31.01	40.15	65.15	54.17	25.12	22.09	12.00	11.00	9.99	10.00
Nov	43.95	37.08	66.04	60.29	23.54	19.10	8.00	7.00	8.25	8.50
Dec	70.69	45.13	68.98	63.22	19.40	17.67	4.00	2.00	8.13	8.30
Jan	74.97	48.32	69.04	53.18	17.90	17.13	3.00	1.00	8.38	8.40
Feb	55.85	41.11	66.78	57.02	18.60	17.39	1.00	2.00	9.39	9.50
Mar	28.22	19.38	63.90	48.17	19.12	19.11	4.00	3.00	11.15	11.50
Apri	13.50	2.07	61.10	55.42	22.37	22.00	6.00	6.00	12.12	12.48
May	0.00	0.00	59.35	60.02	25.58	23.66	9.00	10.00	13.83	13.90
Jon	0.00	0.00	62.44	70.18	26.61	28.08	13.00	15.00	15.14	15.87
Jul	0.00	0.00	66.58	77.92	30.23	31.36	17.00	18.00	17.12	17.23

Was maintained under rainfed condition without irrigation, serving as the control.

Measured traits and statical analysis:

During the experiment, data were collected on several morphological, yield and quality, related traits of faba bean as mentioned by Dooren and Kassam, 1979.

The measured parameters included:

- **Plant height (cm):** measured at least 10 main stems from the soil surface to the tip of plant at physiological maturity.
- **Number of pods per plant:** average 10 plants.
- **Number of seeds per pod:** average 10 pods.
- **Pod length (cm):** average of 10 pods.
- **Pod seeds weight:** average of 10 pods.
- **Number of seeds per plant**, average of 5 plants.
- **Weight of plant seeds (g),** average of 5 plants.
- **Biological yield (kg/ha):** Total a bove-ground dry biomass of the central plot at harvest.
- **Economic yield (kg/ha):** seed yield from the central rows of each plot adjusted to 13% moisture.
- **Harvest index (H1%):** calculated as the ratio of seed yield to biological yield multiplied by 0.100-seed weight (g): determined by weighing 100 air-dried seeds 3 times randomly sampled from each plot.
- Seed protein content (%): determined using the kjeldahl method based on nitrogen concentration multiplied by 5.25 as showed by yassen *et al*., 2022.

Statistical analysis:

The collected data were subjected to analysis of variance (ANOVA) by helping of Genstat -8 programe and means compared using least significant difference LSD at P > 0.05 as recorded by snedecor and Cochran, 1989.

Results discussion:

table 2 revealed the response of crop traits to supplementary irrigation in the two seasons.

The findings of this study highlight the significant role of (SP in enhancing the growth, yield component, and quality of faba bean under, semi-arid conditions.

- Vegetative growth: plant Hight was significantly increased by sp in 2nd season, with irrigation every 7 days resulting in the tallest plants 103. 40 cm. the non-significant difference in the first season may be attributed to more favorable rainfall conditions table 1. This suggests that impact of irrigation on vegetative growth is more pronounced under drier environments, similar finding showed by Abid *et al*., 2017.
- Yield components: several reproductive traits responded positively to irrigation especially when water was supplied every 7 days (table 2):
- Pod length was significantly increased in both seasons, indicating enhanced pod development due to better water availability during flowering and pod filling stages. Amany *et al*., 2025 discussed the physiology effect of water at these stages.
- Seed per pod. Show highly significant improvement in the first season (up to 5.7 seeds), but no significant differences were observed in the second season. This suggests environmental variability (table 1) played a role in the plant's response, Doorehbos and Kassam, 1979 showed the same seasons.

Table (2): Effect of supplementary irrigation on Local variety of faba bean yield and its attributes during the first season 2022-2023 and second season 2023-2024 at El- Osaita conditions.

Characteristics	Rainfed		Sp every 10 days		Sp every 21 days		F		LSD	
	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season	1st season	2nd season
Plant height (cm)	94.84	75.40	95.13	103.40	95.04	102.13	N.s	*	-	23.21
Pods per plant	6.11	6.02	6.99	7.58	6.42	6.52	N.s	N.s	-	-
Pod length (cm)	15.41	13.27	16.20	14.94	15.44	14.11	*	*	0.52	0.68
Seeds / pods	3.70	6.02	5.70	7.57	4.92	6.52	**	N.s	0.77	-
Seed- pods weight (g)	6.64	6.17	8.98	7.80	8.56	7.76	**	N.s	0.52	-
Seed per plant	31.30	34.28	41.12	39.70	34.40	34.70	**	*	5.18	4.12
Plant seeds weight (g)	21.20	25.00	35.10	34.20	31.00	29.28	*	*	8.79	44.29
Biological yield kg ha^{-1}	29.20	3940	3830	5620	3380	4810	N.s	*	-	1650
Seed yield kg ha^{-1}	12.00	1900	2090	3690	1910	3070	N.s	*	-	1080
Harvest index (%)	41.09	48.22	54.56	65.66	56.50	63.83	*	*	7.71	9.17
100- seed weight (g)	44.59	62.35	53.88	67.58	44.79	62.95	**	**	4.44	2.67
Seed Protoin %	18.70	22.67	24.65	19.27	22.37	21.78	**	N.s	3.21	-

Ns: not significant at P < 0.05 level

***:** significant at P < 0.05 level.

****:** significant at P < 0.01 level.

Seed weight per pod not seeds plant were significantly improve under frequent irrigation, particularly in the first season, these traits were closely linked with pod filling and overall productivity, both of which benefit from adequate moisture al harbi and Adhinkari, 2020 show the similar findings.

Seed weight per plant was significantly affected in both seasons, where irrigation every 7 days gave the heaviest seed weight (35.1 and 34.29) (Table 2) this confirms the cumulative on benefit of frequenent watering on total seed accumulation per plant. Similar discuse reported by A many *et al*., 2025.

Yield performance:

Biological yield was significantly improved the 2nd (table 2) season only, where frequent irrigation increased biomass production from 3940 kg/ha (rainfed) to 5620 kg/ha.

Sarkar et al., 2017 show similar results.

Economic (Grain) yield showed a similar pattern, with no significant differences in the 1st season but a substantial increase in the second (table 2) (sp) every 7 days increased yield from 1900 to 3690 kg/ha, demonstrating its effectiveness under stress conditions, similar trend reported by manal *et al*., 2022.

Harvest index and seed quality:

(HI) was significantly affected by irrigation in both seasons. The highest HI values were obtained from the 21-day treatment in the first season (56.50%) and the 7-day treatment in the second season (65.66%) (Table 2) these findings suggest that irrigation not only increase yield but also improves the efficiency of assimilate partitioning toword the seeds, similar reason noted by Grain and Haile, 2010.

100- seed weight:

100- seed weight increased significantly under irrigation reaching up to 67.589 with 7-day irrigation, indicating better seed development and filling, these results were in accordance with those Sakar et al., 2017.

Protein content:

Protein content was highly significantly affected in the first season and significantly in the second (table 2), with the highest values consistently observed under 7 day. Irrigation (up to 24.65%) this improvement in nutritional quality reflects better nitrogen assimilation under adequate water a vialability.

Conclusion:

The study clearly demonstrates that supplementary irrigation particularly every 7 days significantly enhances both the quantity and quality of faba bean yield under El- Osaita semi-arid conditions. Key yield components such as seed number, seed weight, and protein content benefited from regular moisture supply, especially in seasons with limited rainfall. While some traits showed variable responses between season-likely due to climatic differences the general trend confirms that supplementary irrigation improves water use efficiency and crop performance in water- limited environments.

Recommendation:

The maximize faba bean productivity and seed quality in similar agro- ecological zones, it is recommended to apply supplementary irrigation every 7 days from sowing to physiological maturity. especially in seasons with low or irregular rainfall.

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